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TECHNICAL MANUAL

APOLLO-SATURN
EMERGENCY DETECTION SYSTEM
DESCRIPTION

(AS-500 Series Vehicles)

Prepared under Contract

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by

International Business Machines Corporation

Federal Systems Division

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PREFACE

This manual contains a system description of the Emergency Detection System (hereafter referred to as EDS) employed on the Apollo-Saturn 500 Series Vehicles.

Since the EDS was designed for a manned Apollo-Saturn Vehicle, the descriptions in this manual are based on the EDS for such a vehicle. For unmanned vehicles, some of the functions normally performed by a crew are performed by ground personnel through the use of RF command links. Differences between the EDS on manned and unmanned vehicles are noted as applicable in the text and on the illustrations.

It has been assumed herein that the user of this manual is generally familiar with the Apollo-Saturn program and has some knowledge of the purposes of the various sections or stages that compose the Saturn Launch Vehicle and the Apollo Spacecraft. Where the term Spacecraft is used, it generally implies the 3 sections of the Apollo Spacecraft (i.e., Command Module, Service Module, and Lunar Excursion Module) as being a single unit forward of the Saturn Instrument Unit.

Section I of this manual contains a general system description of the EDS. This section includes both functional and physical general descriptions. Section II covers EDS principles of operation in more detail than in Section I. Emphasis is placed on the relay logic used and the sequence of operation. Section III contains separate descriptions of each major EDS component. Descriptions are included for only those components that are used primarily for EDS. Section IV briefly describes the ground support equipment available for checkout of EDS. Section V provides change information for each vehicle as this information is added to the manual. The Appendixes to the manual contain reproductions of the EDS Interface Control Documents for Apollo-Saturn Vehicles.

NOTICE

Apollo-Saturn Vehicle Data Sheets (hereafter referred to as Data Sheets) are provided in Section V to supplement the basic EDS concepts contained within Sections I through IV of this manual and must be used in conjunction with these sections.

The Data Sheets are tabulated by vehicle number and are designed to provide current updated changes to the EDS circuits and the corresponding operation and sequence changes.

CONTENTS

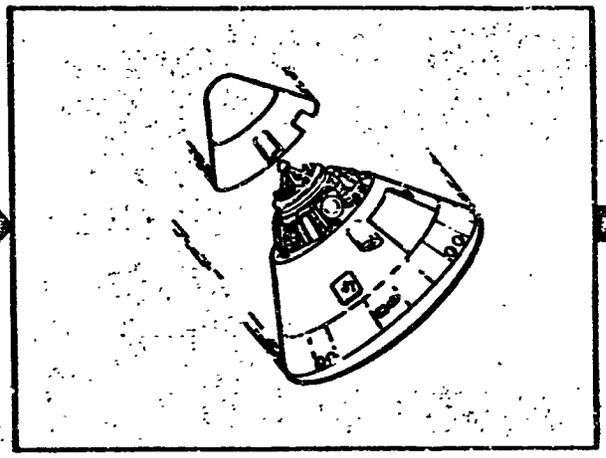
ILLUSTRATIONS

NOTE

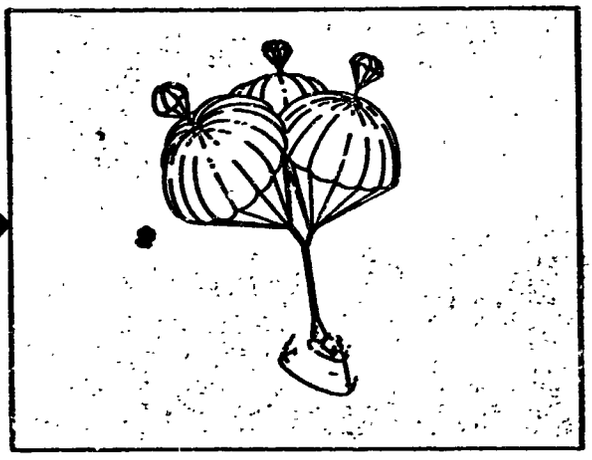
The abort sequences are depicted here in the sequence of events from the initiation of either an automatic or a manual abort to the successful completion of the abort sequence.

To follow the abort sequence, determine which emergency condition (number 1 on left side of figure) exists and follow the numerical sequence across the figure.

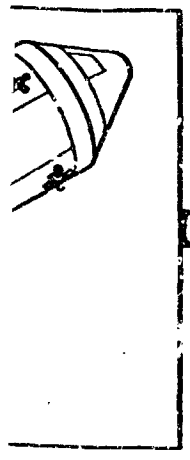
6 Apex cover jettisoned and drogue chutes released from command module.



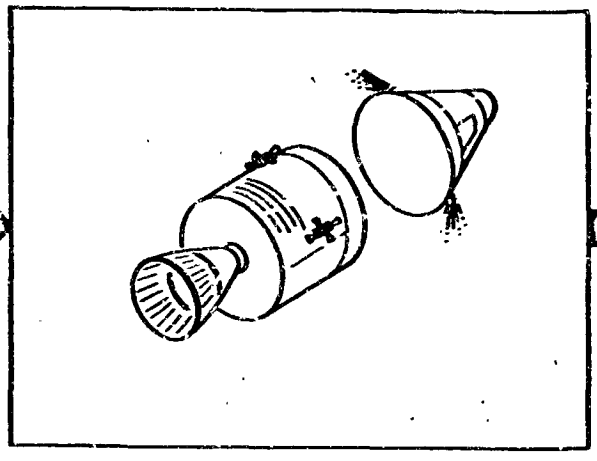
7 Drogue chutes release main chutes and Command Module lowered to earth.



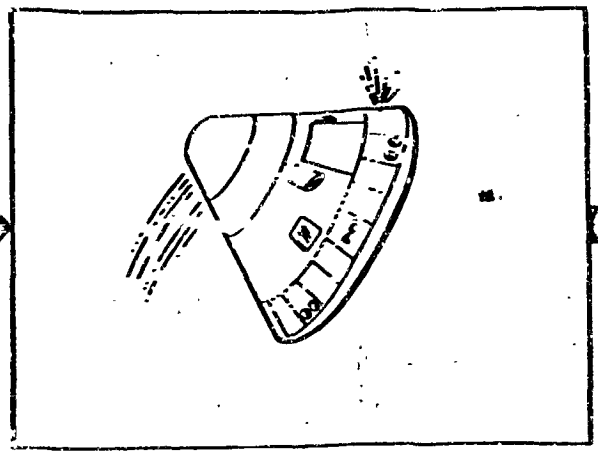
e pulled free
e engine.



5 Service Propulsion System engine cut-off and Command Module separated from Service Module.

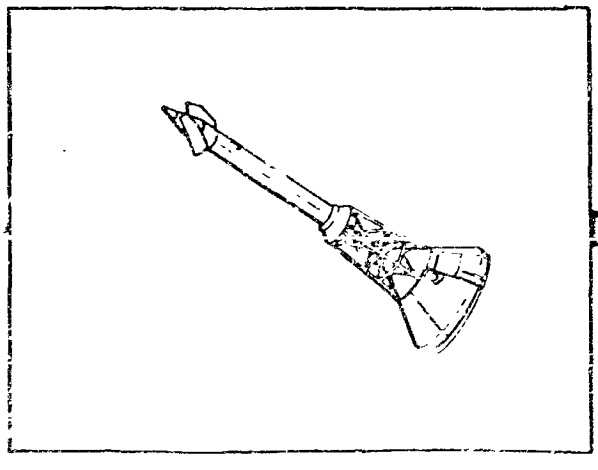


3 Command Module reaction control system, damps and orients Command Module for proper re-entry attitude.

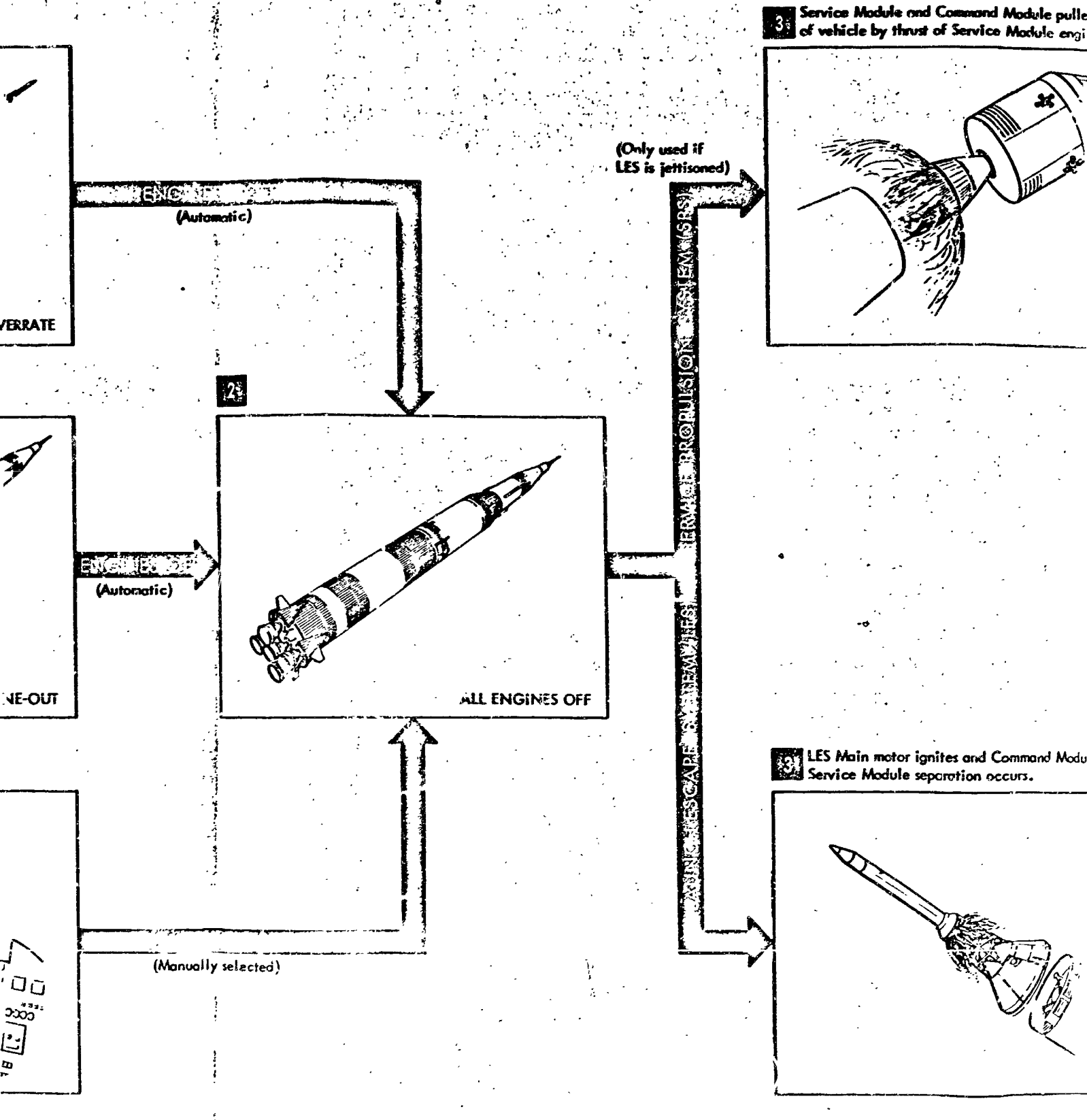


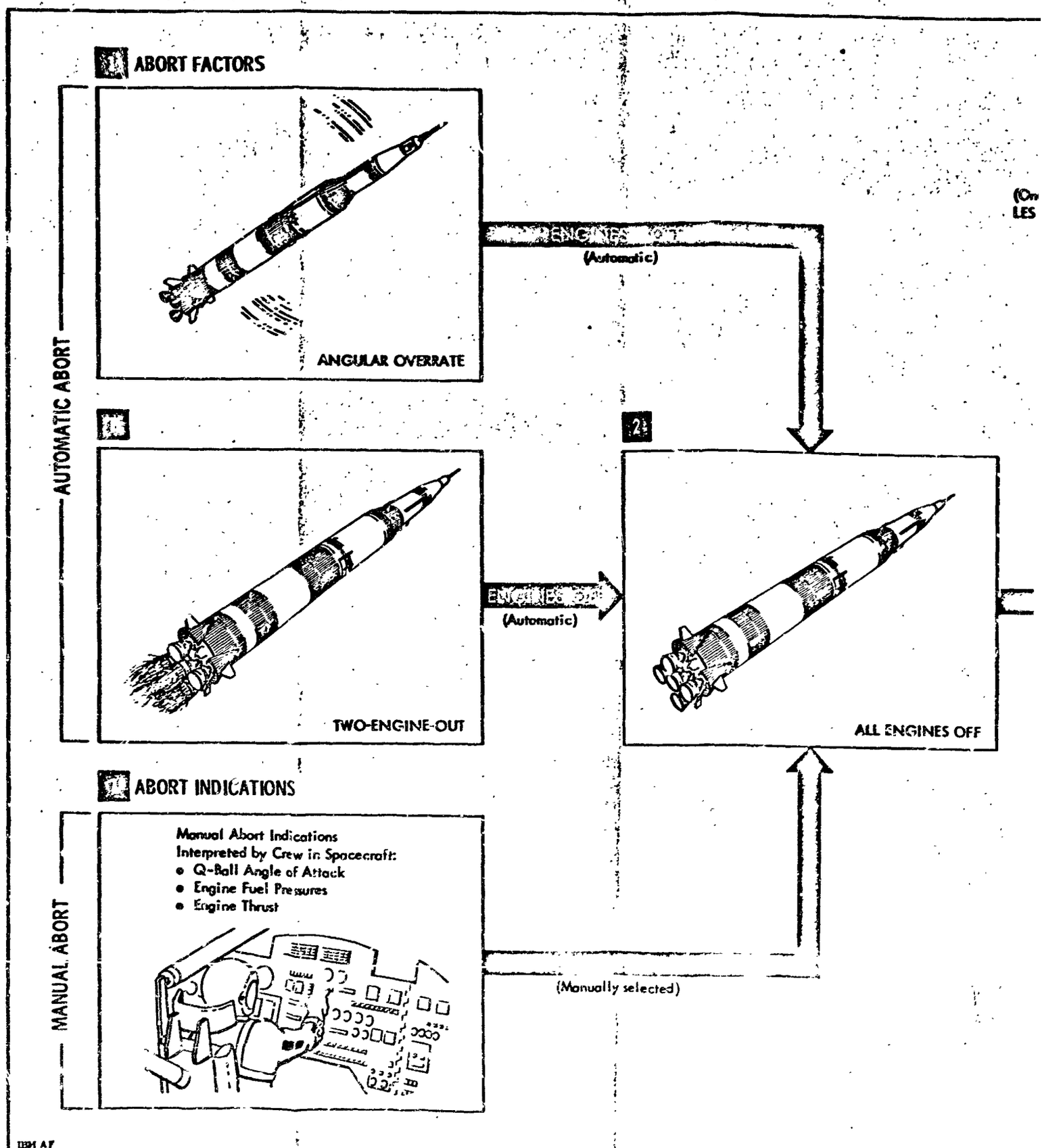
d Module/

4 Canard deployment effect and damp turn-around maneuver.



2 Tower and boost cover jettisoned from command module.


3. Service Module and Command Module pulle
of vehicle by thrust of Service Module engi
(Only used if
LES is jettisoned)
(Automatic)
2.
(Automatic)
ALL ENGINES OFF
TERMINATE PROPULSION SYSTEM (SPS)
ARMING ESCAPE SYSTEM (ES)
(Manually selected)
3. LES Main motor ignites and Command Modu
Service Module separation occurs.



Automatic and Manual Abort Sequence Apollo-Saturn 500 Series Vehicles

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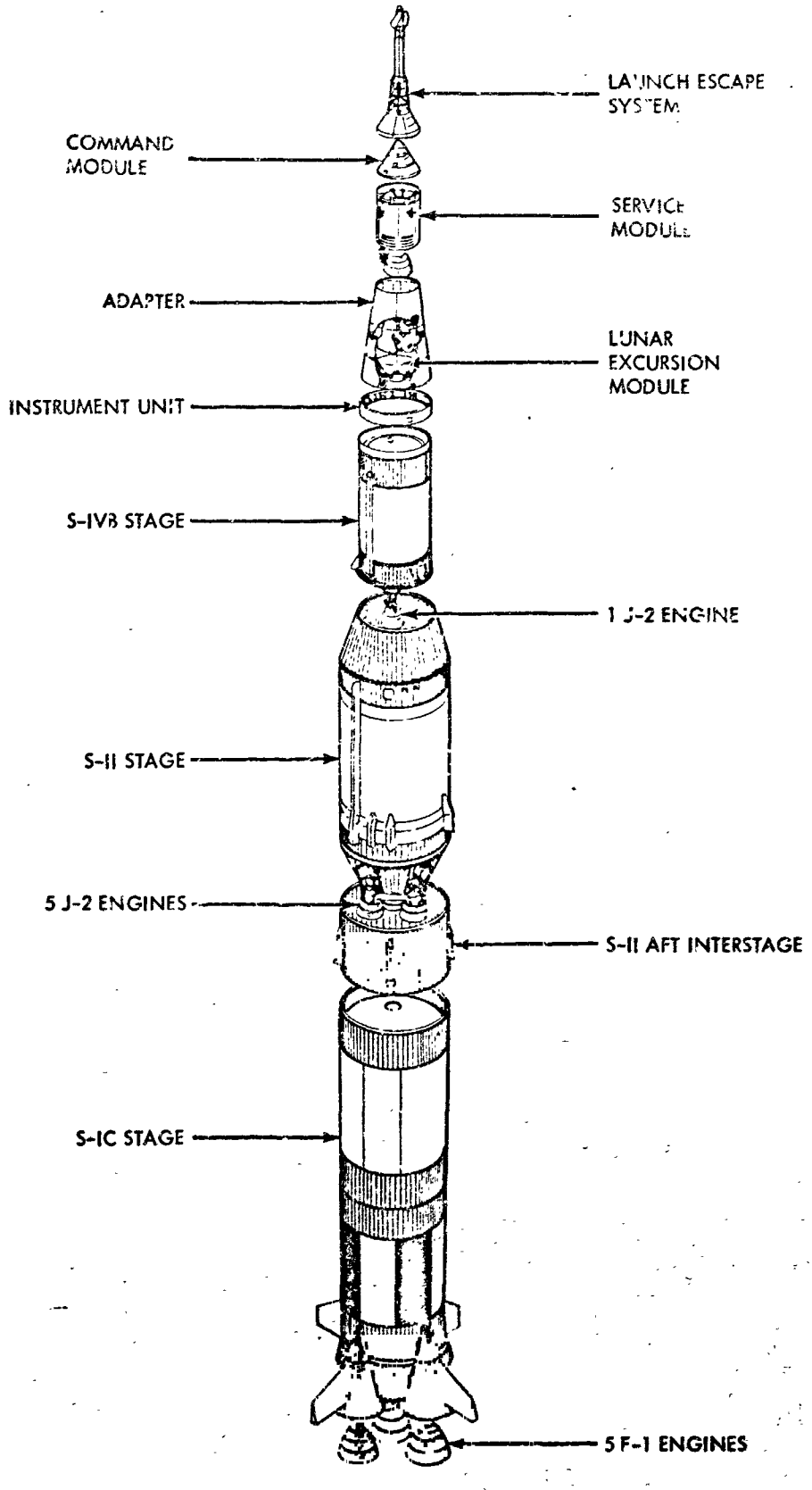
ILLUSTRATIONS



APOLLO-SATURN V VEHICLE

SECTION I

GENERAL SYSTEM DESCRIPTION

This section briefly describes the purpose of the EDS and includes general descriptions of the functional and physical characteristics of the system.

1-1 PURPOSE

The purpose of the EDS is to sense and act upon onboard emergency situations arising during Saturn-boosted phases of Apollo-Saturn space flights. Protection of the Apollo crew against failure of the Saturn vehicle is the prime function of the EDS. However, for protection of personnel at the launch area, certain portions of EDS are deactivated until a short interval after liftoff. This deactivation period prevents EDS cutoff of all engines and the resulting fall-back of the vehicle on the launch area.

1-2 GENERAL FUNCTIONAL DESCRIPTION

The EDS reacts to emergency situations in one of two ways, depending upon the seriousness of the emergency. If the EDS senses an emergency that will lead to rapid vehicle breakup, the EDS automatically initiates an abort sequence for the safety of the Apollo crew. If, however, the emergency is of such nature that the crew has time to evaluate the effects of the emergency, the EDS furnishes only visual indications of the specific emergency present. The crew then makes the decision of whether or not to manually initiate an abort sequence. Once initiated, either automatically by the EDS or manually by the crew, the abort sequence runs to completion automatically.

An EDS initiation of an abort is hereafter referred to as an automatic abort. Crew initiation of an abort is hereafter referred to as a manual abort.* The visual emergency indications given by the EDS are called manual abort indications.

Portions of the EDS are deactivated during some phases of vehicle flight. This deactivation is controlled manually by the crew or automatically by the normal flight sequencing circuits of the vehicle. The time of deactivation is determined by mission plans and safety factors.

A general block diagram of the EDS appears in Figure 1-1. Not all components shown are primarily for EDS use. However, inputs from or outputs to these components are required for complete functioning of the EDS. Those components used primarily for the EDS are indicated by heavy lines.

The following paragraphs describe the general functioning of the EDS in three separate parts: automatic abort, manual abort, and abort sequence. A definite functional distinction exists between the initiation phase of an abort (consisting of automatic abort and manual abort) and the actual abort-sequence phase.

1-3 AUTOMATIC ABORT

Either of the following emergency conditions can cause an EDS automatically initiated abort of the Apollo-Saturn vehicle:

- An excessive angular rate of the vehicle about either the pitch, yaw, or roll axis.
- Loss of thrust (below 89 percent of rated thrust) on any two of the five S-IC engines during first-stage boost.

An automatic abort resulting from the first condition is referred to as an angular-overrate automatic abort. The second condition for automatic abort is referred to as a two-engine-out automatic abort.

Upon detection of either of these two emergency conditions, the EDS will energize an auto abort bus in the EDS Distributor. Energizing this bus then causes a signal to be sent to the Command Module to automatically initiate the abort sequence.

At any time during flight, the crew can inhibit this automatic initiation of an abort. Inhibiting is

* On unmanned vehicles, a manual abort can be initiated only by ground personnel through an RF command link.

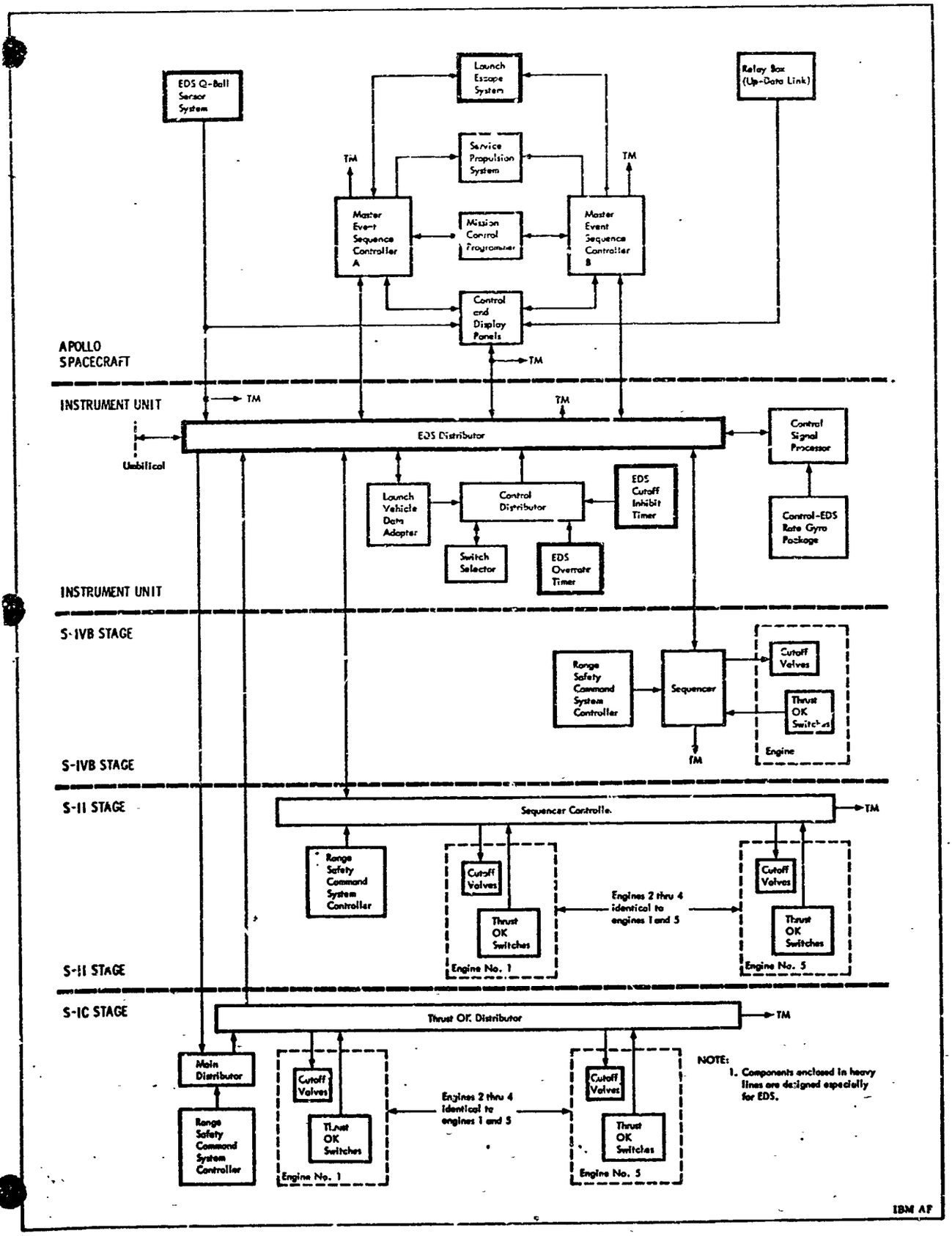


Figure 1-1. Emergency Detection System General Block Diagram

performed by deactivating the inputs fed to the auto abort bus from both the angular-overrate and the two-engine-out automatic abort circuitry. This deactivation must occur, however, before the auto abort bus has been energized. (The times of deactivation, or inhibiting, by the crew * had not been determined as of the date on this manual.)

Inhibiting of automatic abort circuitry is also provided by the vehicle flight sequencing circuits through the Instrument Unit (IU) Switch Selector. This inhibiting is required prior to normal S-IC engine cutoff and other normal vehicle sequencing. While the automatic abort is inhibited, the Apollo crew must initiate a manual abort if an angular-overrate or two-engine-out condition arises.

1-4 MANUAL ABORT

On manned flights, a manual abort is initiated within the Command Module by the Apollo crew.** A pilot's hand controller in the Command Module is used to start the abort sequence. The crew's decision of whether to initiate a manual abort can be made at any time while the Spacecraft is attached to the Saturn vehicle.

The decision to initiate a manual abort must be based on at least two separate and distinct indications of a vehicle emergency or malfunction. These two indications may be obtained from EDS displays, from information telemetered to ground and relayed back to the crew, from physiological sensing of a malfunction by the crew, or any combination of these. Although the two indications obtained may imply the presence of the same malfunction (for instance, one engine out), the two indications must not be derived from the same sensing and indicating system. For example, if the EDS indicates to the crew that one engine is out, and a one-engine-out signal is also telemetered to the ground (and relayed back to the crew), it cannot be necessarily assumed that the engine is actually out. The reason for not making this assumption is that both indications originated within the same sensing circuit. (A failure in the sensing circuit could have caused both erroneous indications.) If, however, the EDS indicates that one engine is out, and the crew also senses a reduction in vehicle acceleration, it can be reasonably assumed that the engine is actually out. (Whether or not the crew initiates a manual abort, as a result of this one-engine-out condition, is dependent upon the specific mission rules for that flight.) If any conflict arises between on-board EDS indications and the telemetered information that is relayed back to the crew, the on-board indications will always take precedence.

Only some of the on-board visual indications (required for manual abort decisions) are provided by the EDS. Other on-board visual indications are provided by the Spacecraft Guidance and Navigation System. In both cases, these indications are called manual abort indications and are displayed in the Command Module by indicator lights, meters, or other types of displays. Each of the indicator lights used contains either 2 or 4 lamps. The indicator lights are constructed so that the crew cannot distinguish whether all or only one of the lamps in the indicator is ON.

The manual abort indications displayed in the Command Module are as follows:

- Saturn vehicle angular overrate about any axis, when signaled by at least 1 of 3 gyros used for that axis (one dual-lamp indicator).
- S-IC engine out (one dual-lamp indicator for each engine). ***
- S-II engine out (one dual-lamp indicator for each engine). ***
- S-IVB engine out (one dual-lamp indicator for the single engine). ***
- S-II second plane separation (one dual-lamp indicator to indicate separation of S-II aft interstage).
- Saturn vehicle attitude reference failure (one dual-lamp indicator).
- Abort request from ground control before or after liftoff (one four-lamp indicator).
- Angle of attack (meter indication from EDS Q-Ball Sensor System).
- S-II and S-IVB fuel tank pressures (4 meters).
- Attitude error (meter type indication from Spacecraft Guidance and Navigation System).

* Not applicable for unmanned vehicles.

** On unmanned vehicles, a manual abort can be initiated only by ground personnel through an RF command link.

*** Only five engine-out indicators are in the Command Module. This set of 5 indicators is used for engines of the S-IC, S-II, and S-IVB Stages.

- Angular overrate (meter type indication from Spacecraft Guidance and Navigation System).

1-5 ABORT SEQUENCE

As mentioned previously, the EDS abort sequence can be initiated either by an automatic abort condition or by a crew activated manual abort. To permit continuation of the abort sequence after an automatic initiation, the following conditions must first be satisfied:

- Auto abort enabling signals must have been received from the launch complex prior to liftoff.
- Liftoff must have occurred.
- An AUTO ABORT ENABLE switch in the Command Module must be set to ABORT.

The need for the first 2 of these 3 conditions can be bypassed, or overridden, by the crew.* This override is accomplished by depressing a MANUAL ABORT ENABLE pushbutton in the Command Module. (The name MANUAL ABORT ENABLE is used in EDS documentation but may be misleading because the pushbutton has no connection with the manual abort function.)

Only when the preceding conditions have been properly satisfied can the abort sequence continue after an automatic initiation.** No such conditions need be satisfied prior to or after a manual abort initiation.

When an abort sequence is initiated, either automatically or manually, the sequence normally cuts off all engines of the operating stage.*** (EDS engine cutoff is inhibited, however, until a specific time interval after liftoff. This inhibiting prevents the vehicle from falling back on the launch area.)

Regardless of whether the abort sequence succeeds in cutting off the engines, the sequence continues and selects either a Launch Escape System (LES) abort mode or a Service Propulsion System (SPS) abort mode. The sequencing that occurs in either abort mode causes removal of the Command Module from the malfunctioning Saturn vehicle.

Whether the LES mode or the SPS mode is selected during the abort sequence depends upon an interlock circuit through the LES tower. If the LES is still attached to the Command Module at abort sequence initiation, the LES mode is selected. In this mode, the Command Module is separated from the rest of the Apollo-Saturn vehicle and propelled away by the LES main motor. If, however, the LES had been previously jettisoned by the crew or by normal vehicle flight sequencing, the SPS mode is selected. In this mode, the Command Module and the Service Module are separated from the rest of the vehicle and propelled away by the Service Module engine.

After the Command Module is propelled a safe distance from the vehicle, the Command Module separates from the LES or the Service Module. Parachutes then lower the Command Module to a safe landing.

1-6 GENERAL PHYSICAL DESCRIPTION

A general physical description of the EDS is limited because most of the components involved in EDS operation are considered components of other systems of the Apollo-Saturn vehicle. Interconnections with these other systems are essential, however, for complete functioning of the EDS.

All components directly involved in EDS operation are shown in Figure 1-1. Components designed primarily for the EDS (i.e., EDS major components) are listed in Table 1-1 and are shown enclosed in heavy lines in Figure 1-1. The major EDS components are described in Section III of this manual.

The control and display panels indicated by the block Control and Display Panels in Figure 1-1 are shown in detail in Figures 1-2 through 1-5. Only the switches and indicators referred to in this manual are indexed in the figures. Since the panel labeling of the switches and indicators may not be sufficiently descriptive, more descriptive nomenclature is used within the manual. In the legend for each figure, a cross reference is made between the actual labeling on the panel and the nomenclature used in the manual.

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* Not applicable for unmanned vehicles.

** On Vehicle AS-501, the abort sequence cannot continue because the AUTO ABORT ENABLE switch is purposely left at OFF.

*** On Vehicle AS-501, no EDS abort-sequence cutoff of the engines is possible.

Table 1-1. Emergency Detection System Major Components

Nomenclature	Reference Designation	Location
Launch Escape System	———	Top of Spacecraft
EDS Q-Ball Sensor System	900A408	Top of Launch Escape System
EDS Distributor	602A5	Instrument Unit
EDS Cutoff Inhibit Timer (40-Second or 60-Second)*	603A56	Instrument Unit
EDS Overrate Timer (20-Second)	603A58	Instrument Unit
* 40 or 60 Seconds depending upon vehicle mission		

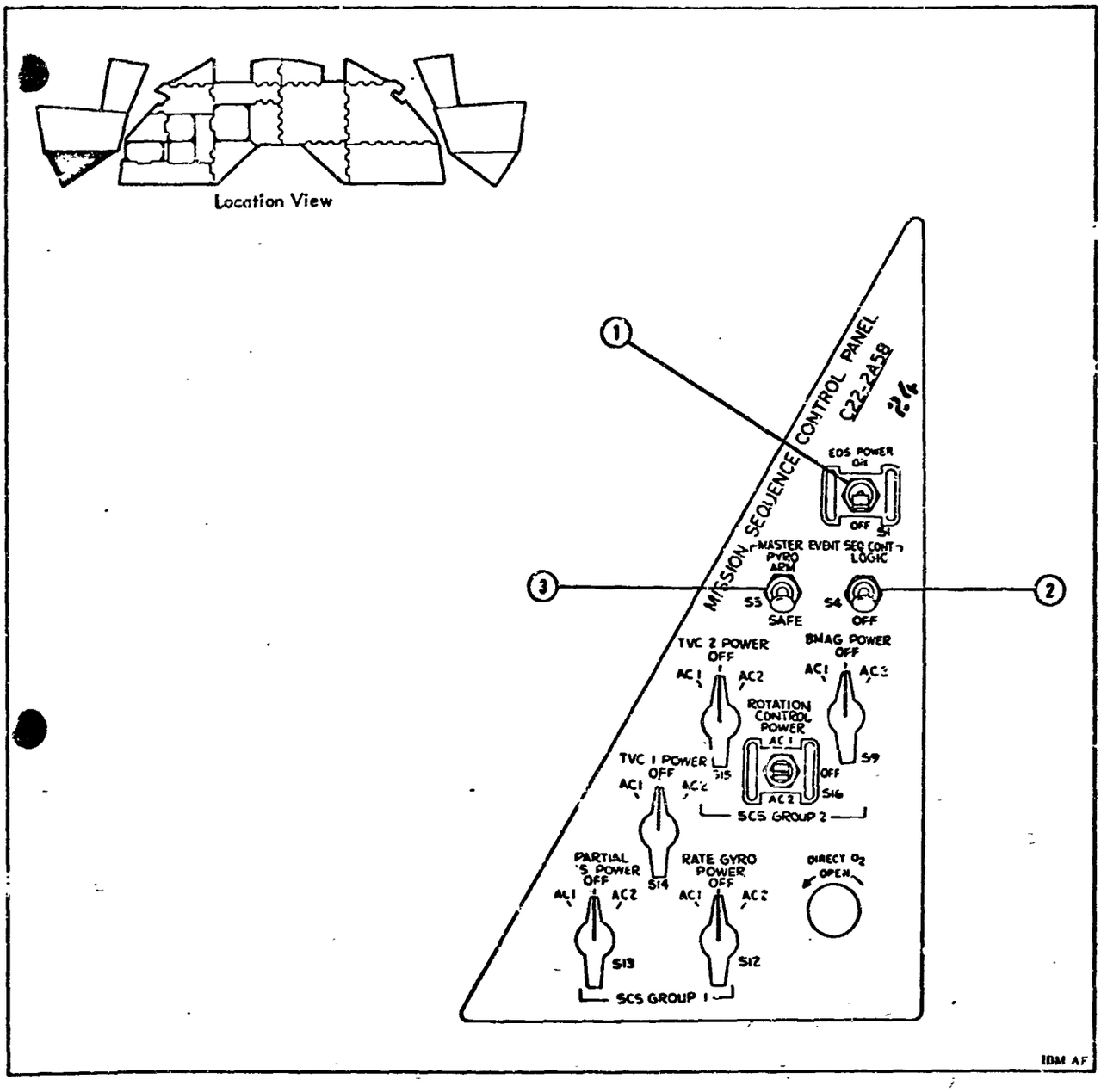

Figure 1-2. Mission Sequence Control Panel (Panel 24)

Legend for Figure 1-2

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	EDS POWER	EDS POWER
2	MASTER EVENT SEQ CONT-LOGIC	MASTER EVENT SEQUENCE CONTROLLER LOGIC
3	MASTER EVENT SEQ CONT-PYRO	MASTER EVENT SEQUENCE CONTROLLER PYRO

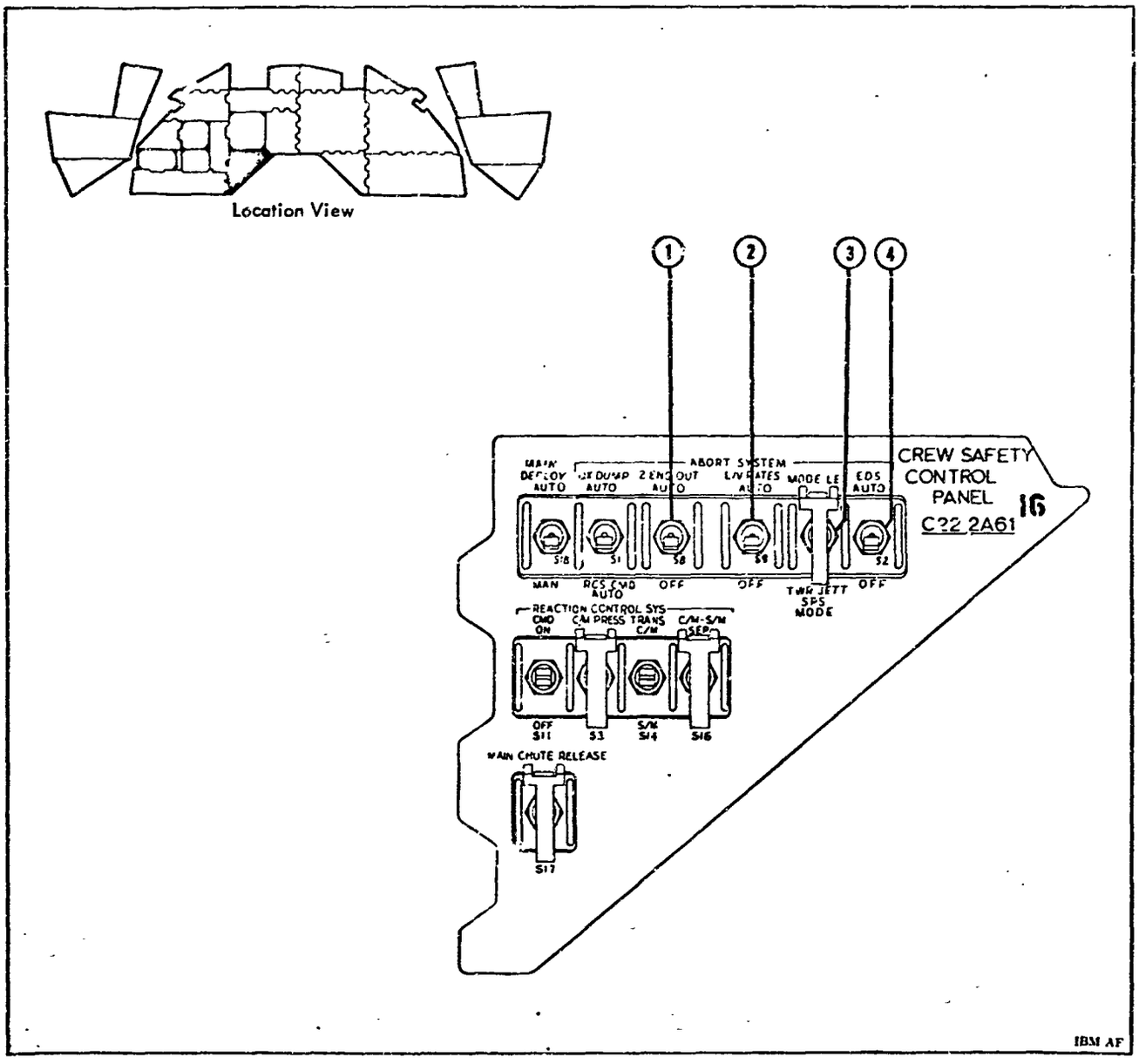

Figure 1-3. Crew Safety Control Panel (Panel 16)

Legend for Figure 1-3

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	ABORT SYSTEM - 2 ENG OUT	S-IC TWO ENGINE OUT AUTO ABORT DEACTIVATE
2	ABORT SYSTEM - L/V RATES	RATE EXCESSIVE AUTO ABORT DEACTIVATE
3	ABORT SYSTEM - MODE LES - TWR JETT SPS MODE	LES JETTISON
4	ABORT SYSTEM - EDS	AUTO ABORT ENABLE

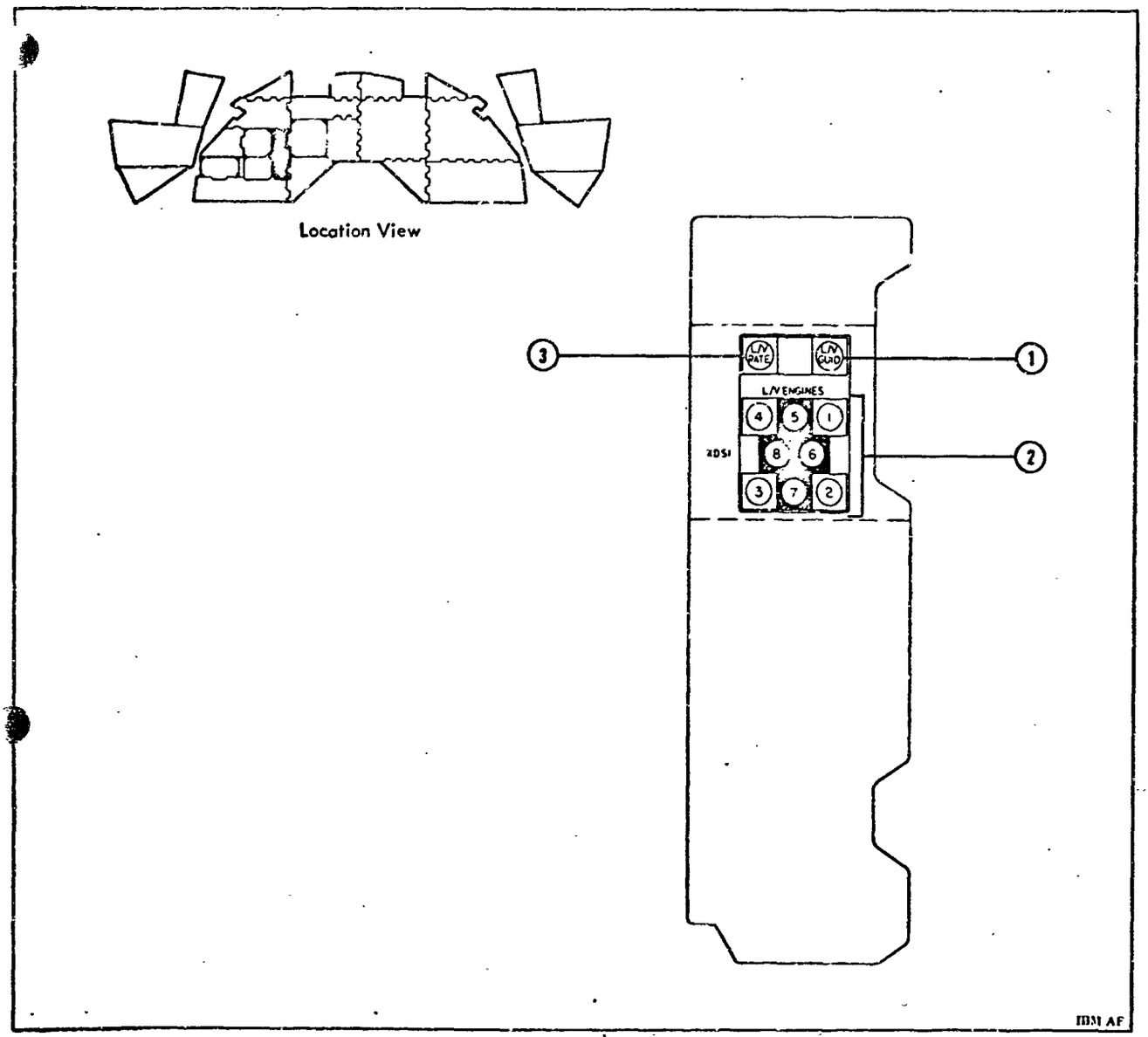

Figure 1-4. Emergency Detection System Sequencer Display Panel (Panel 5)

Legend for Figure 1-4

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	L/V GUID	LV ATT REF FAIL
2	L/V ENGINES	ENG NO. 1 OUT S-IC, S-II, OR S-IVB (for indicator 1); ENG NO. (*) OUT S-IC and S-II (for indicators 2 through 5); S-II Second Plane separation (for indicator 6); Indicators 7 and 8 are spare.
3	L/V RATE	LV RATE EXCESSIVE

* Number of respective engine

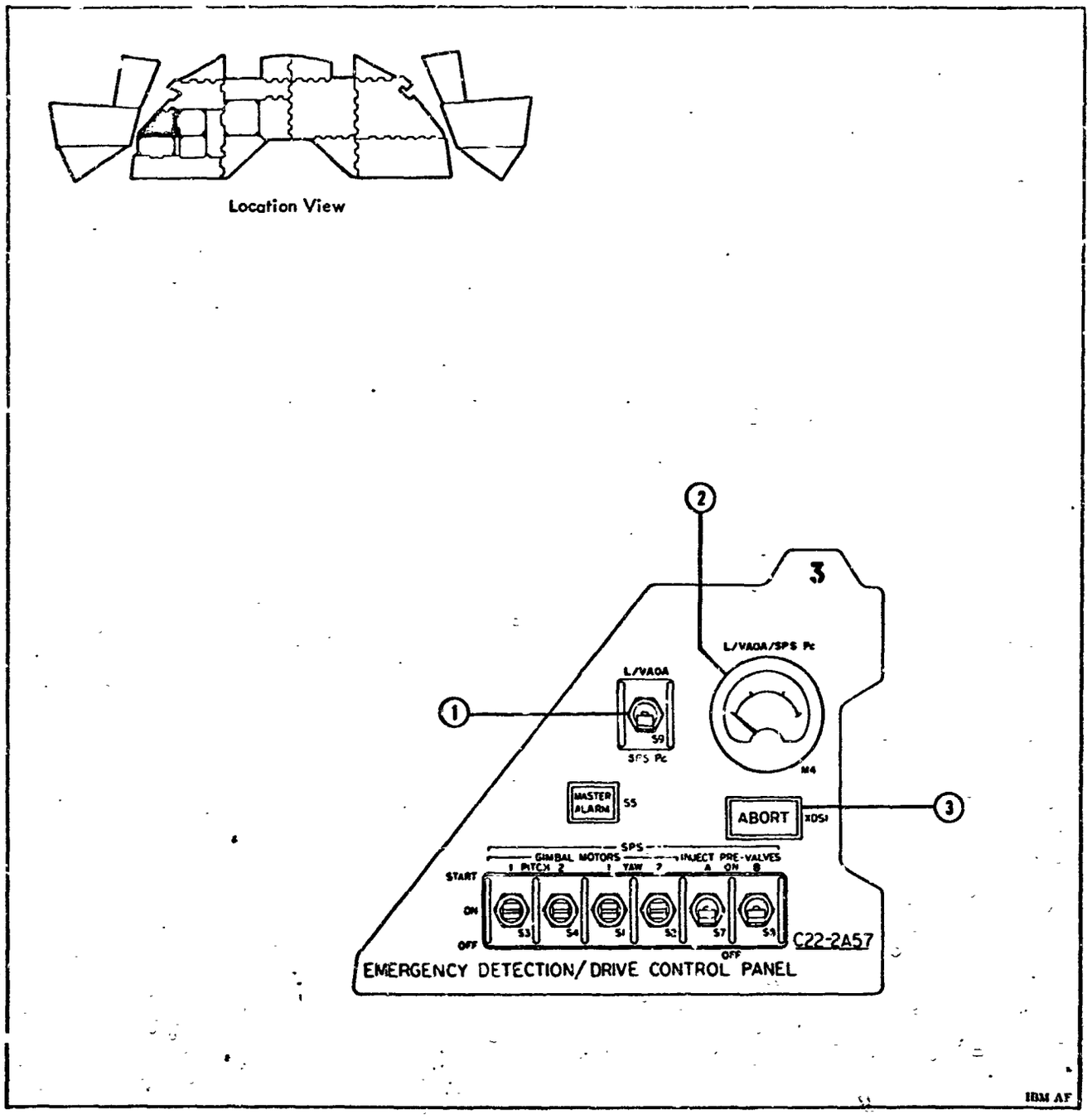

Figure 1-5. Emergency Detection/Drive Control Panel (Panel 3)

Legend for Figure 1-5

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	L/VAOA-SPS Pc	LV A OF A - SPS PC
2	L/VAOA/SPS Pc	Angle of Attack
3	ABORT	ABORT REQUEST

SECTION II
SYSTEM PRINCIPLES OF OPERATION

Section II includes, first, a general description of the methods employed to increase EDS reliability. Power sources for the EDS are then briefly described. Following these descriptions, the phases of EDS operation are covered in detail. For ease of explanation (although contrary to electron theory), current is considered to flow from +28 V buses, through operating circuits, to negative (common) buses.

Functional schematics which support the text are included at the end of the section. These schematics do not show all the connections to the various components. For instance, none of the outputs to telemetry or to ground support equipment are indicated. Neither are power sources shown. For more detailed schematics (although still not complete), refer to the Appendix.

2-1 EDS INTERNAL RELIABILITY

To maintain a high degree of reliability, one main principle has been applied to the operation of all EDS circuitry. This principle is that no single failure within the EDS will be allowed to cause an inadvertent abort, nor will any single failure prevent an abort when an actual emergency arises. To ensure this proper operation, both triple-redundant circuitry and duplex circuitry are employed. Triple-redundant circuitry (with 2-out-of-3 voting) is used for most of the automatic abort sensing circuits and automatic abort initiation circuits. Duplex circuitry is used for the abort sequence circuits and the indicating circuits for manual abort. Triple-redundant and duplex power sources are also utilized.

To further increase reliability, EDS circuitry is arranged to prevent ground loops. To accomplish this, the EDS circuits between vehicle stages, and between the IU and the Spacecraft, do not use the same power sources nor the same grounding points. When circuits in one stage require information from another stage, 28 V power is first supplied by the stage requiring the information. This 28 V is fed to contacts of relays whose coils are controlled by the stage possessing the desired information. After passing through the relay contacts, the resulting 28 V EDS signal is returned to the stage originally supplying the 28 V power. In this manner, valid EDS signals can be transferred between stages without the possibility of false EDS signals being generated by ground loops.

2-2 EDS POWER SOURCES

Although not shown on the functional schematics in this section, 28 V power for the EDS in each Saturn stage is supplied by batteries within that stage only. Each stage contains two or more batteries which supply power for separate +28 V buses. No electrical connection is made from a power source in one stage to a power source in any other stage. However, +28 V and ground returns from each stage are supplied to special +28 V and COM buses in each of the other stages. Power from these special buses is then used in providing EDS signals to the respective stages that originally supplied the power.

Power for the EDS circuits in the Spacecraft is supplied by three Spacecraft batteries. As is the case between stages of the Saturn vehicle, +28 V and ground returns are provided between the Spacecraft and the IU.

Three switches in the Command Module control the power for the Spacecraft EDS circuits. These switches are the EDS POWER switch, the MASTER EVENT SEQUENCE CONTROLLER LOGIC switch, and the MASTER EVENT SEQUENCE CONTROLLER PYRO switch.

2-3 ABORT PHASES OF OPERATION

As mentioned in Section I, a definite functional distinction exists between the initiation phase of an abort and the actual abort-sequence phase. Also, the initiation phase is subdivided into automatic abort initiation and manual abort initiation. These three functional areas (called automatic abort, manual abort, and abort sequence) are therefore described separately.

2-4 AUTOMATIC ABORT

An automatic abort can be initiated only by an angular overrate condition or an S-IC two-engine-out condition. In both cases, the automatic abort is considered to be initiated when the auto abort bus in the EDS Distributor is energized. The following paragraphs describe how this bus becomes energized by the sensing of either of the two emergency conditions.

2-5 ANGULAR OVERRATE AUTOMATIC ABORT

An angular overrate condition for an automatic abort is sensed by a combination of 2 components: the Control-EDS Rate Gyro Package and the Control Signal Processor. As indicated in Figure 2-1, angular rate signals are generated in the Control-EDS Rate Gyro Package by 3 gyros for each axis (roll, yaw, and pitch). These rate signals are fed to individual rate circuits, called rate switches, in the Control Signal Processor. If the angular rate of the vehicle about one of its axes exceeds a preset value, or rate limit, the rate switches for that axis will each produce a +28 V output. Each output closes a relay to indicate an angular overrate condition for that axis. At least two of the three rate switch relays for one axis must close to indicate an overrate condition for the axis.

The rate limit, above which an overrate is indicated, is changed one time during flight for the yaw and pitch axes. No inflight change is made in the rate limit for the roll axis. For yaw and pitch axes, the rate limit is preset at 5 degrees per second before the inflight change and 5 degrees per second after the change. (On Vehicles AS-501 and 502 the rate limit for pitch and yaw axes is set at 5 degrees per second and does not change during flight.) The rate limit for roll remains preset at 20 degrees per second.

The rate limit change for yaw and pitch axes is controlled by latching relays K171 and K172 or relays K173 and K174 in the EDS Distributor. Approximately 20 seconds after liftoff, the Switch Selector energizes K171 and K172, and the EDS Overrate Timer deenergizes K173 and K174. (On Vehicle AS-501, the EDS Overrate Timer energizes K173 and K174. Refer to notes on Figure 2-1.)

If an overrate occurs about the roll axis, rate switch relays K150, K151, and K152 will close. Positive 28 V is then fed to a roll overrate voting circuit in the EDS Distributor. This voting circuit consists of relays K159 and K160, with associated diodes. The relays and diodes are arranged so that a +28 V output is provided by the voting circuit only when 2 or more of its 3 inputs are +28 V. An output from the voting circuit passes through normally closed contacts of inhibiting relays K165, K166, and K167 to energize the auto abort bus. Energizing the auto abort bus initiates an abort sequence (refer to paragraph 2-15).

To prevent energizing the auto abort bus by a roll angular overrate, inhibiting relays K165, K166, and K167 can be energized. These relays can be energized by a RATE EXCESSIVE AUTO ABORT DEACTIVATE switch in the Command Module.* Normally, however, the inhibiting relays are controlled by latching relays K240 and K241 or K242 and K243 in the Control Distributor. Relays in the Control Distributor are controlled, in turn, by the Switch Selector.

Three inhibiting relays are employed in the inhibit circuitry so that a single relay malfunction cannot cause an undesired inhibit. Conversely, a single relay malfunction cannot prevent a desired inhibit.

The times during which the inhibiting relays are energized are determined by mission plans. While the automatic abort is being inhibited, the Apollo crew must make the decision as to when an abort is necessary. A manual abort may then be initiated by the crew.**

The method used to energize the auto abort bus for a pitch or yaw angular overrate is very similar to that described for a roll angular overrate. Outputs from both the yaw and the pitch voting circuits, however, are fed through a single group of inhibiting relay contacts (Figure 2-1). These inhibiting relays are energized in almost the same manner as are the roll inhibiting relays. The difference is that the roll inhibiting relays can be energized by the Switch Selector without also energizing the yaw and pitch inhibiting relays. The converse, however, is not true. That is, the yaw and pitch inhibiting relays cannot be energized without also energizing the roll inhibiting relays. This difference in operation is caused by the addition of diodes between the coils of relays K165 and K168, K166 and K169, and K167 and K170 (see Figure 2-1).

2-6 TWO-ENGINE-OUT AUTOMATIC ABORT

A two-engine-out condition for an automatic abort is sensed by engine thrust pressure switches

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* Not applicable for Vehicles AS-501 and 502.
** On unmanned vehicles, a manual abort can be initiated only by ground personnel through an RF command link.

in conjunction with relay logic circuitry. As shown in Figure 2-2, three thrust pressure (thrust OK) switches are used for each of the five S-IC engines. The thrust OK switches remain closed as long as engine thrust remains at least 89 percent of rated thrust. With the thrust OK switches closed, relays in the Thrust OK Distributor remain energized and no output is applied to the EDS Distributor.

If the thrust of engine number 1 falls below 89 percent, the respective thrust OK switches will open. Opening of these switches deenergizes relays K1, K2, and K3 in the Thrust OK Distributor. Positive 28 V is then fed through the relay contacts to an engine-out voting circuit for engine number 1 in the EDS Distributor. (Other contacts of K1, K2, and K3 are used in automatically cutting off engine number 1; refer to paragraph 2-16.)

The engine-out voting circuit (Figure 2-2) in the EDS Distributor is composed of relays K175 and K176 with associated diodes. The relays and diodes are arranged so that a +28 V output is provided by the voting circuit only when 2 or more of its 3 inputs are +28 V. An output from the voting circuit is applied to a two-engine-out logic circuit. This logic circuit consists of relays K191 through K200 with associated diodes.

If two or more engines lose thrust, the two-engine-out logic circuit will receive +28 V inputs from two or more engine-out voting circuits (see Figure 2-2). If engines number 1 and 2 lose thrust, for instance, +28 V will be furnished to relays K191, K192, K193, and K194 and the associated diodes. With these relays energized, +28 V from the engine number 1 voting circuit is fed through the now closed contacts of K193, and the normally closed contacts of inhibiting relays K207 and K208, to energize the auto abort bus. Also, +28 V from the engine number 2 voting circuit is fed through the now closed contacts of K192 and through inhibiting relays K207, K208, and K209 to energize the auto abort bus. Thus, two +28 V outputs are furnished to energize the auto abort bus, which in turn, initiates an abort sequence. A similar abort initiation will occur if any other two (or more) of the S-IC engines lose thrust.

To prevent energizing the auto abort bus, by a two-engine-out condition, inhibiting relays K207, K208, and K209 can be energized. These relays can be energized by a S-IC TWO ENGINE OUT AUTO ABORT DEACTIVATE switch in the Command Module.* Normally, however, the inhibiting relays are controlled by latching relays K244 and K245 in the Control Distributor. The relays in the Control Distributor are energized, in turn, by the Switch Selector just before normal engine cutoff.

Three inhibiting relays are employed in the inhibit circuitry so that a single relay malfunction cannot cause an undesired inhibit. Conversely, a single relay malfunction cannot prevent a desired inhibit.

The times during which the inhibiting relays are energized are determined by mission plans. While the automatic abort is being inhibited, the Apollo crew must make the decision as to when an abort is necessary. A manual abort may then be initiated by the crew.

2-7 MANUAL ABORT

On manned flights, a manual abort is initiated within the Command Module by the crew. The abort is begun by setting the pilot's hand controller to ABORT. (On unmanned vehicles, relays in a Mission Control Programmer functionally take the place of the pilot's hand controller. These relays are controlled by ground personnel through an RF command link.) Upon manual abort initiation, the abort sequence (paragraph 2-15) assumes control and completes the abort.

The crew's decision to initiate a manual abort is governed by the conditions specified in paragraph 1-4. Most of the manual abort indications, which are displayed in the Command Module for the crew, are provided by the EDS (refer to listing in paragraph 1-4). Only those indications provided by the EDS are described in the following paragraphs. (All manual abort indications provided for the crew are also made available to ground personnel via telemetry.)

2-8 ANGULAR OVERRATE INDICATION

An angular overrate condition about any axis is indicated by a dual-lamp LV RATE EXCESSIVE indicator in the Command Module. Both lamps of the indicator will be lit simultaneously if a valid overrate condition occurs. (See Figure 2-3 for a functional schematic.)

When any one rate switch senses an angular overrate from its rate gyro, the respective relay (K150 through K158) in the Control Signal Processor closes. (Refer to paragraph 2-5 for a description of this sequence.) When relay K151 for roll rate switch number 2 closes, +28 V is furnished to energize relay

* Not applicable for unmanned vehicles.

K159 in the EDS Distributor. One set of contacts of energized K159 then supplies -28 V to one of the two lamps of the LV RATE EXCESSIVE indicator in the Command Module. Other sets of K159 contacts are used in a voting circuit for automatic abort (paragraph 2-5). When relay K152 for roll rate switch number 3 closes, a similar operating sequence causes the second lamp in the LV RATE EXCESSIVE indicator to be lit.

Contacts of relays K159, K161, and K163 are interconnected, as are contacts of relays K160, K162, and K164. Consequently, an angular overrate sensed by the number 2 rate switch for any axis will cause 1 lamp of the indicator to be lit. Likewise, an overrate sensed by the number 3 rate switch for any axis will cause the other lamp to be lit.

2-9 S-IC, S-II, AND S-IVB ENGINE-OUT INDICATIONS

Indications of S-IC, S-II, and S-IVB engine-out conditions are provided by a set of five dual-lamp indicators in the Command Module. One indicator is used for each S-IC engine. The same indicators are also used for the five S-II engines. In addition, the indicator for S-IC and S-II engine number 1 also indicates an engine-out condition for the S-IVB engine.

A functional schematic of the engine-out indicating circuitry appears in Figure 2-4. For simplicity, only the circuitry for the combined ENG NO. 1 OUT S-IC, S-II, OR S-IVB indicator is shown.

As described in paragraph 2-6, a loss of thrust on S-IC engine number 1 (sensed by a least two of the thrust OK switches) produces a +28 V output from the redundant voting circuit in the EDS Distributor. This +28 V energizes relays K191 and K192, which are part of the automatic abort two-engine-out logic circuit. Additional contacts of K191 and K192 are utilized in the manual abort engine-out indicating circuit. When K191 and K192 are energized, -28 V from closed contacts of relays K205 and K206 is fed to both lamps of the combined ENG NO 1 OUT S-IC, S-II, OR S-IVB indicator. (Relays K205 and K206 are deenergized at liftoff.)

After separation of the S-IC Stage, the S-II Stage engines are started. Thrust OK switches for the S-II engines remain closed as long as the engines produce proper thrust. If engine number 1 loses thrust, its two thrust OK switches will open. Opening of these switches deenergizes relays K50 and K51 in the Sequencer Controller. With K50 and K51 deenergized, +28 V is fed to relays K201 and K202, respectively, in the EDS Distributor. Relays K201 and K202 cannot be energized, however, unless contacts of latching relays K203 and K204 are set (contacts closed). Relays K203 and K204 are set by the IU Switch Selector after S-IC/S-II Stage separation. With K203 and K204 set, K201 and K202 are energized by the loss of thrust on S-II engine number 1. Positive 28 V is then applied to both lamps of the combined ENG NO. 1 OUT S-IC, S-II, OR S-IVB indicator.

Upon separation of the S-II Stage, the S-IVB Stage engine is started. Thrust OK switches for the S-IVB engine remain closed as long as the engine produces proper thrust. If the engine loses thrust, the thrust OK switches will open. Opening of these switches deenergizes relays K100 and K101 in the Sequencer. When K100 and K101 are deenergized, +28 V is fed to normally open contacts of latching relays K212 and K213, respectively, in the EDS Distributor. Relays K212 and K213 are set (contacts closed) by the Switch Selector after S-II/S-IVB Stage separation. If the engine loses thrust after the setting of K212 and K213, -28 V from the contacts of K100 and K101 will energize relays K210 and K211. Positive 28 V is then fed to both lamps of the combined ENG NO. 1 OUT S-IC, S-II, OR S-IVB indicator in the Command Module.

In addition to their being used for emergency detection, the five engine-out indicators are also utilized for indicating normal engine cutoff; for example, prior to vehicle staging.

2-10 S-II SECOND PLANE SEPARATION INDICATION

Separation of the S-II aft interstage from the S-II Stage is indicated in the Command Module by a dual-lamp S-II SECOND PLANE SEPARATION indicator. Both lamps of the indicator remain lit until separation of the aft interstage. Positive 28 V from the S-II Stage is fed through the aft interstage section, back through the S-II Stage, and then applied to 2 relays in the EDS Distributor. These relays remain energized until the aft interstage separates from the S-II Stage (shortly after S-IC/S-II separation). At interstage separation, the 2 relays deenergize and the +28 V through the contacts of each relay is removed from the respective lamp in the S-II SECOND PLANE SEPARATION indicator.

2-11 ATTITUDE REFERENCE FAILURE INDICATION

Failure of the Saturn vehicle attitude reference is indicated by a dual-lamp LV ATTITUDE REFERENCE FAILURE indicator in the Command Module.

currently with corresponding relays K280 and K281 in MESC B. When these 4 relays are energized, power is removed from relays K223 through K226 in the EDS Distributor. Again, triple-redundant relay circuitry is employed to ensure proper operation.

When power is removed from K223 through K226, their contacts close. Positive 28 V is then fed through the contacts of these relays to contacts of latching relays K233 and K234. Relays K233 and K234 are energized (set) at a time determined by mission requirements after liftoff by the EDS Cutoff Inhibit Timer and the Switch Selector, respectively. The 40-second delay prevents EDS cutoff of the engines, and the resulting fall of the vehicle, before the vehicle has cleared the launch area. (On Vehicle AS-501, as indicated in Figure 2-6, there is no connection from the contacts of relays K224 and K226 to the contacts of K233. Also, the Switch Selector is not programmed to operate relay K234. Consequently, no EDS cutoff of the engines is possible on AS-501.)

If relays K233 and K234 have been previously set, the +28 V from contacts of relays K223 through K226 will energize relays K229 through K232. Relays K229 through K232, in turn, provide +28 V cutoff signals to engine cutoff circuitry in the S-IVB, S-II and S-IC Stages.

For cutoff of the S-IVB engine of Vehicles AS-501 and AS-502, the cutoff signals from the EDS Distributor are applied to the Sequencer (Figure 2-7). From the Sequencer, these +28 V cutoff signals are fed to the cutoff bus of the S-IVB engine, thereby cutting off the engine. The cutoff signals in the Sequencer are also applied to a time delay. After 425 milliseconds, a +28 V output from the time delay is supplied to the prevalve control solenoid and the chilldown shutoff valve control solenoid of the engine.

In addition to engine cutoff by the EDS, the S-IVB engine can be cutoff by the stage Switch Selector, the Range Safety Control System, and by depletion of engine propellants. As shown in Figure 2-7, the Switch Selector can individually control the prevalve control solenoid and the chilldown shutoff valve control solenoid, as well as the engine cutoff bus Both the Range Safety Command System and the engine propellant depletion signal energize the solenoids and cutoff bus in essentially the same manner as does EDS.

For EDS cutoff of the five S-II engines, cutoff signals from the EDS Distributor are fed through the S-IVB Stage to relays K67 and K68 in the Sequencer Controller (Figure 2-8). With K67 and K68 energized, +28 V is applied to the engine cutoff bus of each engine, thereby cutting off all engines. (For simplicity, only the circuitry for engine number 1 is shown. The circuitry for the other engines is identical.)

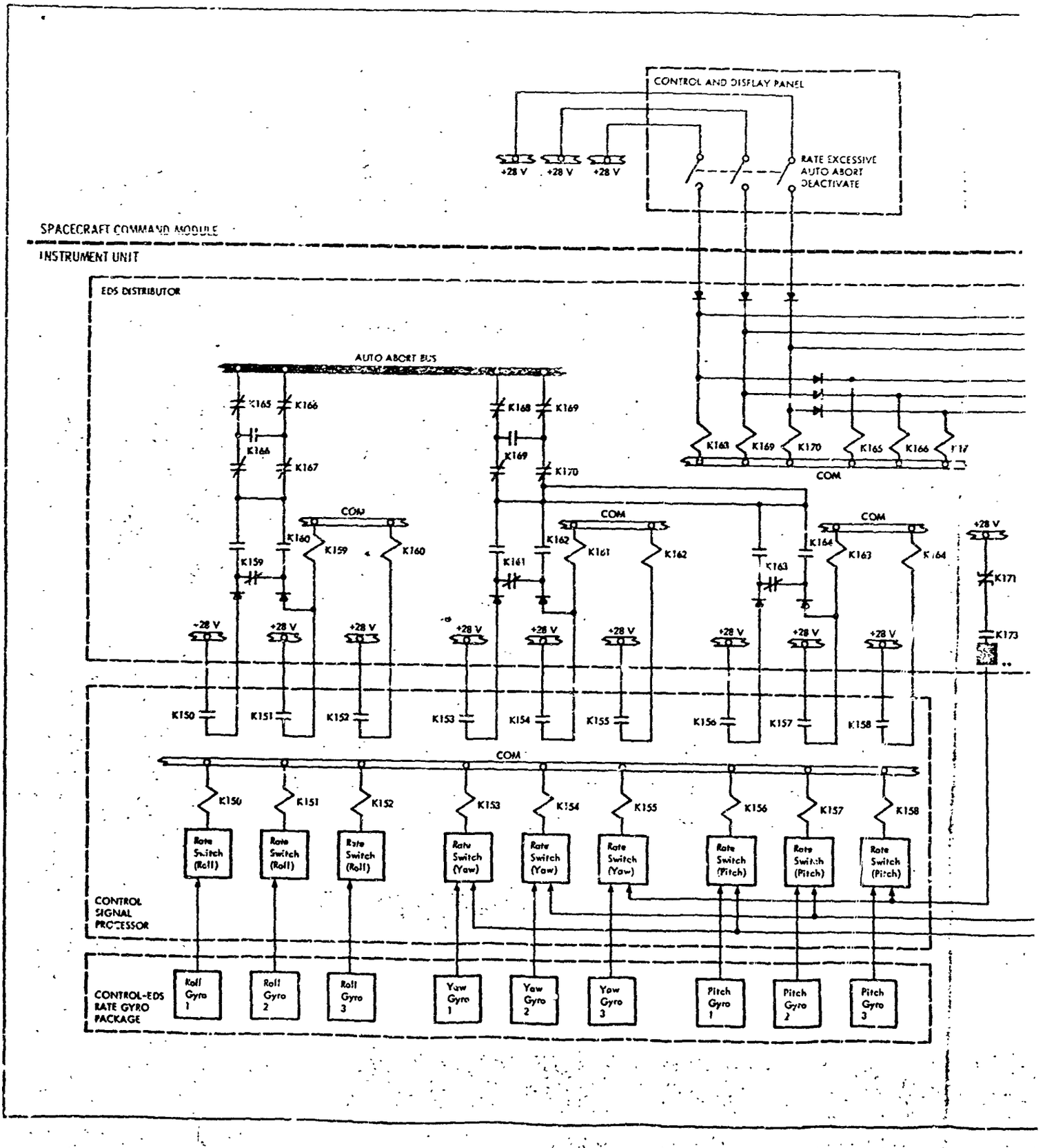
The +28 V applied to the engine cutoff bus (for engine number 1) also energizes relay K69. With relay K62 deenergized at liftoff (or before), +28 V from K62 is fed through the now closed contacts of K69 and is applied to a time delay. (If K69 has not been energized, +28 V from K62 passes through the previously closed contacts of K67 and K68 and is fed to the time delay through the normally closed contacts of K69.) After 425 milliseconds delay, a +28 V output from the time delay energizes relay K70. Positive 28 V through contacts of K70 is then fed to the LH_2 and the LOX prevalve solenoids.

The engines of the S-II Stage can also be cutoff by 4 methods other than EDS cutoff, as shown in Figure 2-8. First, the Switch Selector can cutoff all engines simultaneously. Second, depletion of either the LH_2 or the LOX can cause all engines to be cutoff. Third, all engines can be cutoff simultaneously by the Range Safety Command System. Fourth, internal circuitry of the Sequencer Controller can cutoff any single engine if that engine loses proper thrust (as sensed by the thrust OK switches). This fourth method is dependent, however, upon latching relay K60 being set (contacts closed) by the Switch Selector.

For EDS cutoff of the five S-IC engines, cutoff signals from the EDS Distributor are fed through the S-IVB and S-II Stages to relays K26, K27, and K28 in the Main Distributor (Figure 2-9). With K26 and K28 energized, +28 V is applied to five engine-cutoff relays in the Thrust OK Distributor, one relay for each engine. (For simplicity, the cutoff relays and other circuitry for only engine number 1 are shown in Figure 2-9. The circuitry for engines 2 through 5 is identical.)

When cutoff relay K31 (for engine number 1) is energized from the Main Distributor, +28 V is applied to an engine stop solenoid, which cuts off the engine. In addition, +28 V from contacts of K31 energizes relay K32. (Positive 28 V from energized K27 in the Main Distributor is also fed to K32.) With K32 energized, +28 V through its contacts is applied to the fuel prevalve control solenoid and the LOX prevalve control solenoid.

In addition to engine cutoff by the EDS, the S-IC engines can be cutoff by three other methods, as


CONTROL AND DISPLAY PANEL
+28 V
+28 V
+28 V
RATE EXCESSIVE
AUTO ABORT
DEACTIVATE
SPACECRAFT COMMAND MODULE
INSTRUMENT UNIT
EDS DISTRIBUTOR
AUTO ABORT BUS
K165
K166
K168
K169
K166
K169
K167
K170
K163
K169
K170
K165
K166
COM
COM
COM
COM
K160
K159
K160
K162
K161
K162
K163
K164
K163
K164
K159
K161
+28 V
K171
K173
K150
K151
K152
K153
K154
K155
K156
K157
K158
COM
Rate Switch (Roll)
Rate Switch (Yaw)
Rate Switch (Pitch)
CONTROL SIGNAL PROCESSOR
CONTROL-EDS RATE GYRO PACKAGE
Roll Gyro 1
Roll Gyro 2
Roll Gyro 3
Yaw Gyro 1
Yaw Gyro 2
Yaw Gyro 3
Pitch Gyro 1
Pitch Gyro 2
Pitch Gyro 3

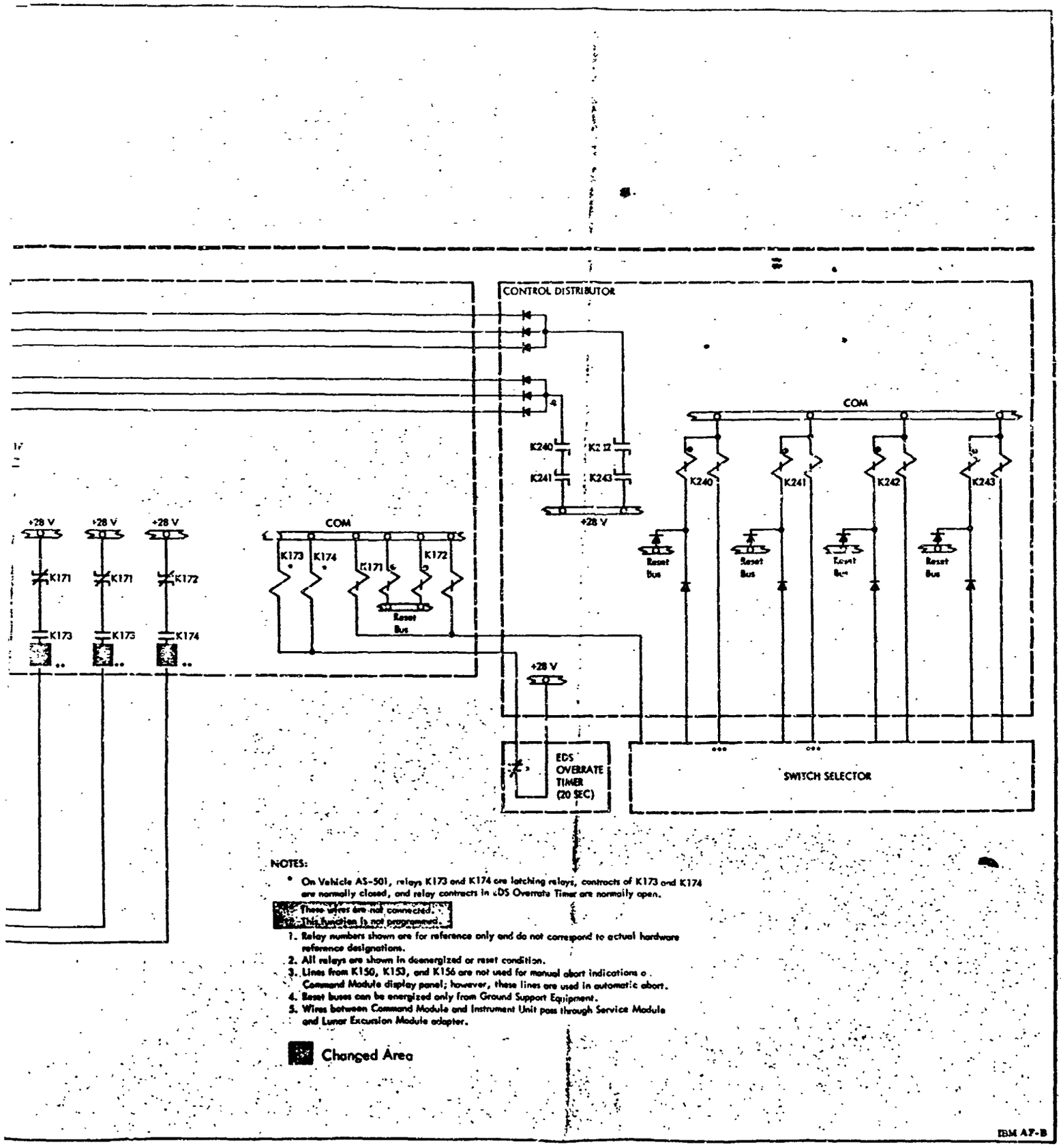
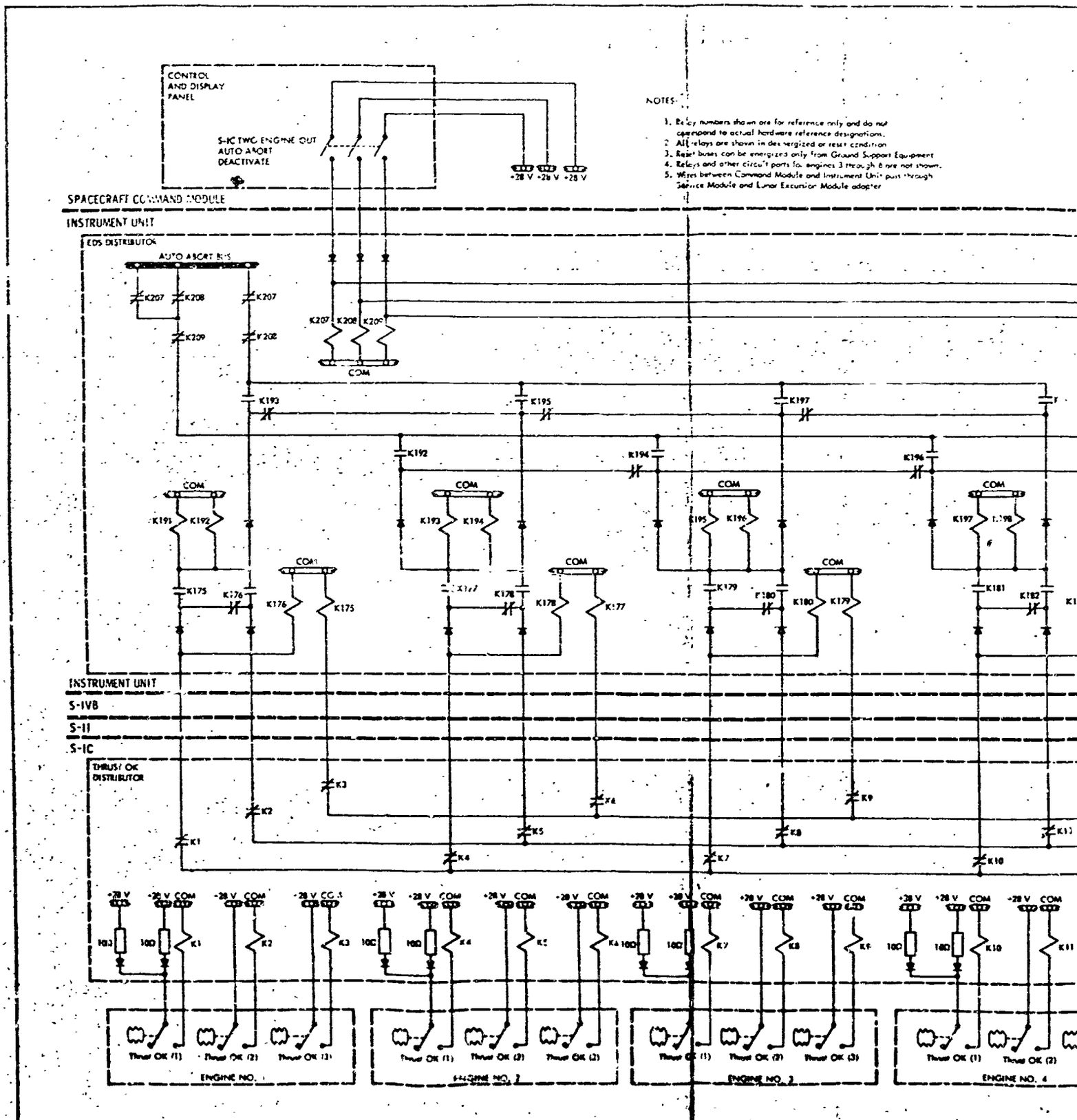


Figure 2-1. Angular Overrate Automatic Abort Functional Schematic


CONTROL AND DISPLAY PANEL
S-IC TWO ENGINE OUT AUTO ABORT DEACTIVATE
+28 V +28 V +28 V
NOTES:
1. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
2. All relays are shown in de-energized or reset condition.
3. Reset buses can be energized only from Ground Support Equipment.
4. Relays and other circuit parts for engines 3 through 6 are not shown.
5. Wires between Command Module and Instrument Unit pass through Service Module and Lunar Excursion Module adapter
SPACECRAFT COMMAND MODULE
INSTRUMENT UNIT
EDS DISTRIBUTOR
AUTO ABORT BUS
K207 K208 K209
COM
K193 K195 K197
K192 K194 K196
K191 K192 K193 K194 K195 K196 K197 K198
K175 K176 K177 K178 K179 K180 K181 K182
INSTRUMENT UNIT
S-IVB
S-II
S-IC
THRUST OK DISTRIBUTOR
K1 K2 K3 K4 K5 K6 K7 K8 K9 K10
+28 V COM
100
Thrust OK (1)
Thrust OK (2)
Thrust OK (3)
ENGINE NO. 1
ENGINE NO. 2
ENGINE NO. 3
ENGINE NO. 4

...ers shown are for reference only and do not
...to actual hardware reference designations.
...are shown in deenergized or reset condition.
...can be energized only from Ground Support Equipment.
...other circuit parts for engines 3 through 6 are not shown.
...een Command Module and Instrument Unit pass-through
...odule and Lunar Excursion Module adapter.

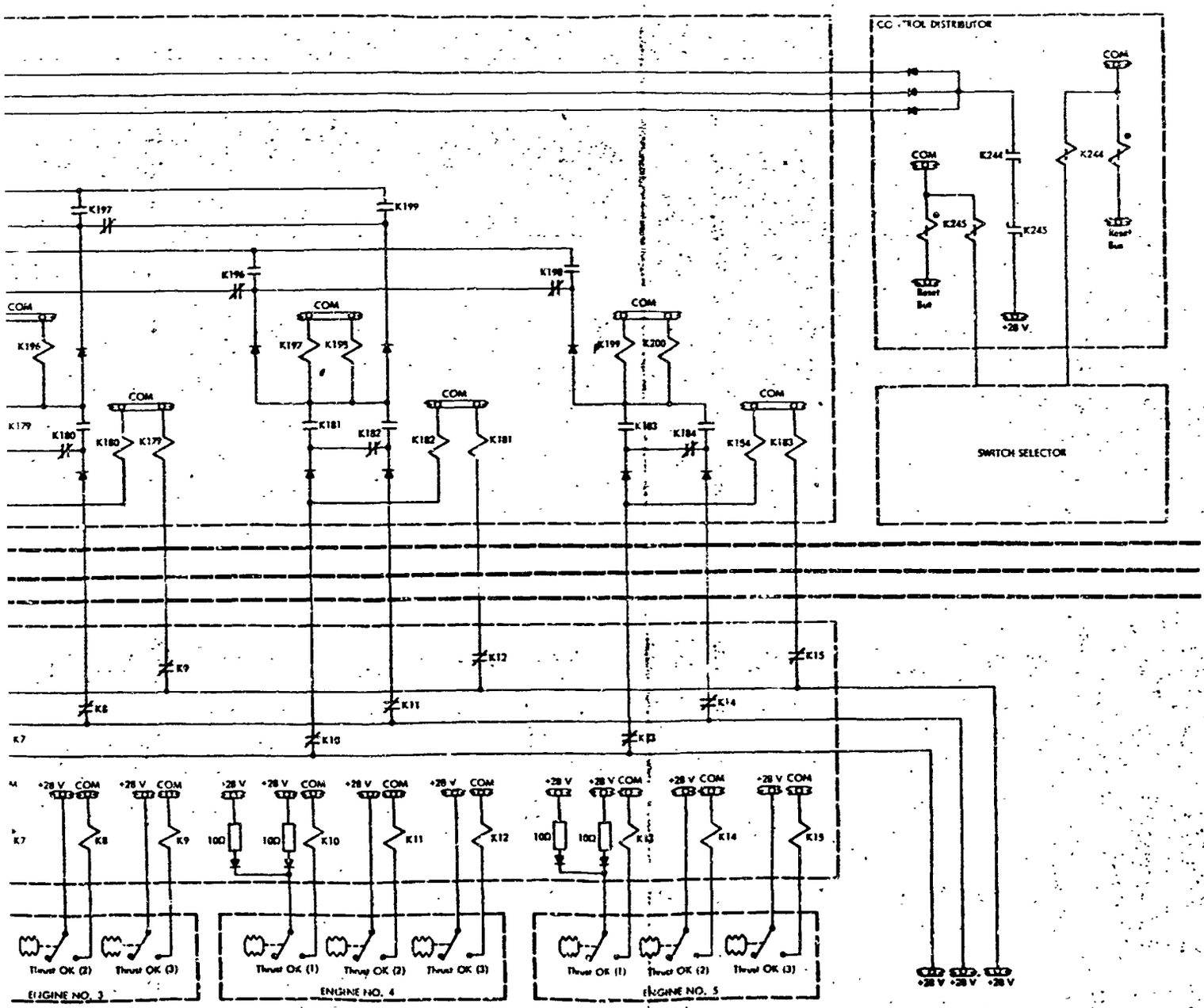


Figure 2-2. S-IC Two-Engine-Out Automatic Abort Functional Schematic

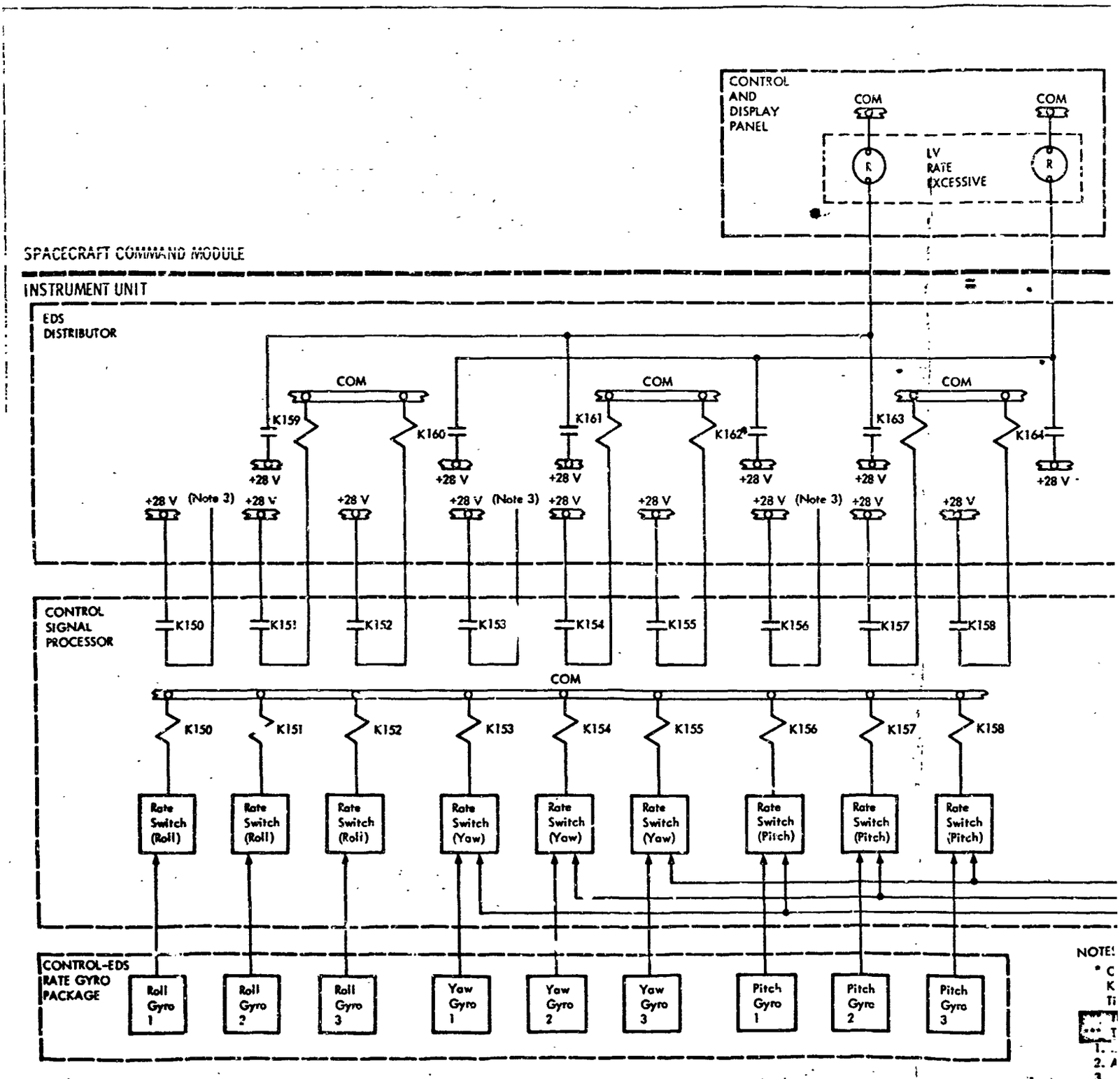

CONTROL AND DISPLAY PANEL
COM
COM
R
R
LV RATE EXCESSIVE
SPACECRAFT COMMAND MODULE
INSTRUMENT UNIT
EDS DISTRIBUTOR
COM
COM
COM
K159
K160
K161
K162
K163
K164
+28 V
+28 V
+28 V
+28 V
+28 V
+28 V
+28 V (Note 3)
+28 V
+28 V
+28 V (Note 3)
+28 V
+28 V
+28 V (Note 3)
+28 V
+28 V
CONTROL SIGNAL PROCESSOR
K150
K151
K152
K153
K154
K155
K156
K157
K158
COM
K150
K151
K152
K153
K154
K155
K156
K157
K158
Rate Switch (Roll)
Rate Switch (Roll)
Rate Switch (Roll)
Rate Switch (Yaw)
Rate Switch (Yaw)
Rate Switch (Yaw)
Rate Switch (Pitch)
Rate Switch (Pitch)
Rate Switch (Pitch)
CONTROL-EDS RATE GYRO PACKAGE
Roll Gyro 1
Roll Gyro 2
Roll Gyro 3
Yaw Gyro 1
Yaw Gyro 2
Yaw Gyro 3
Pitch Gyro 1
Pitch Gyro 2
Pitch Gyro 3

Figure 2-3. A

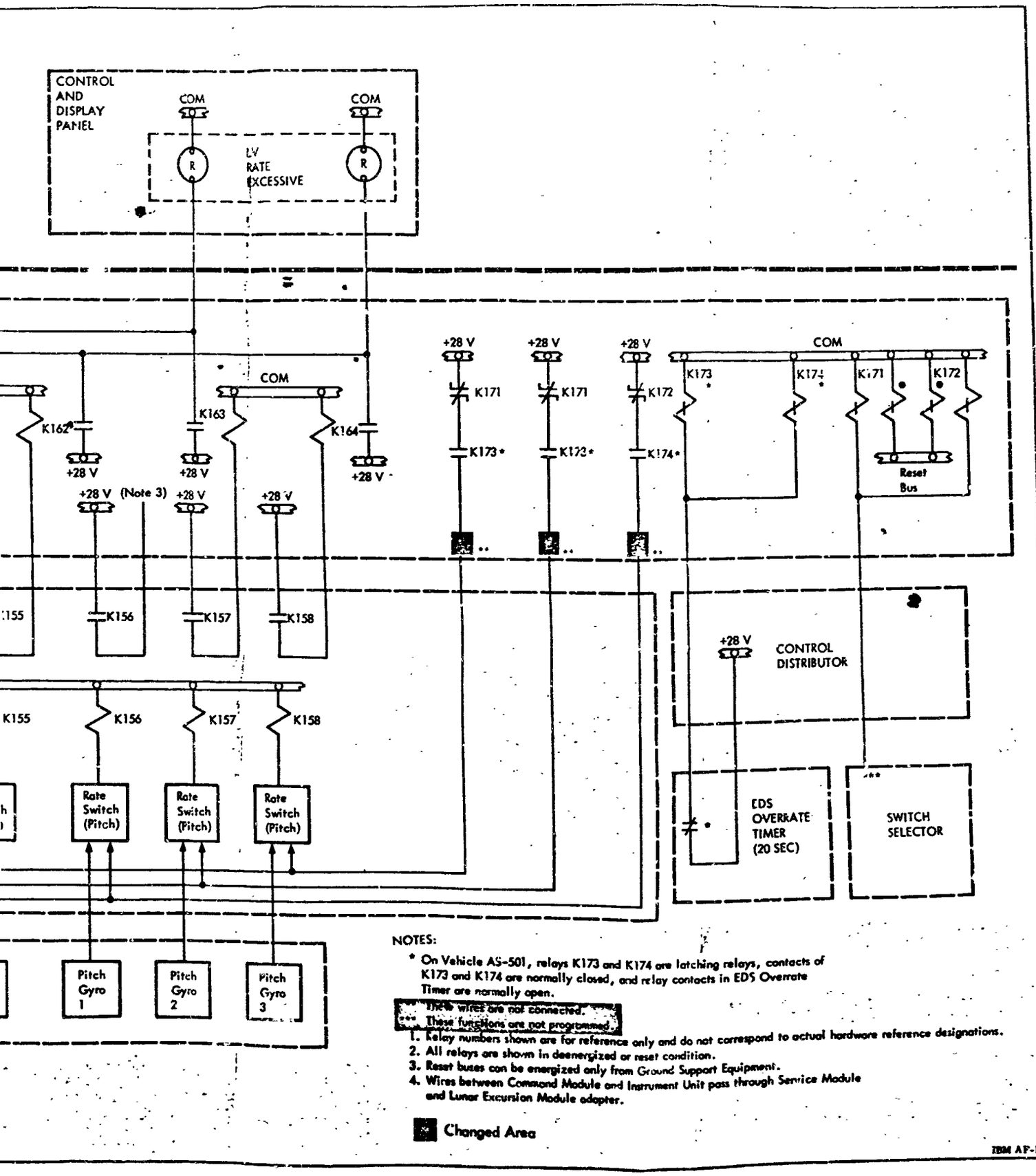
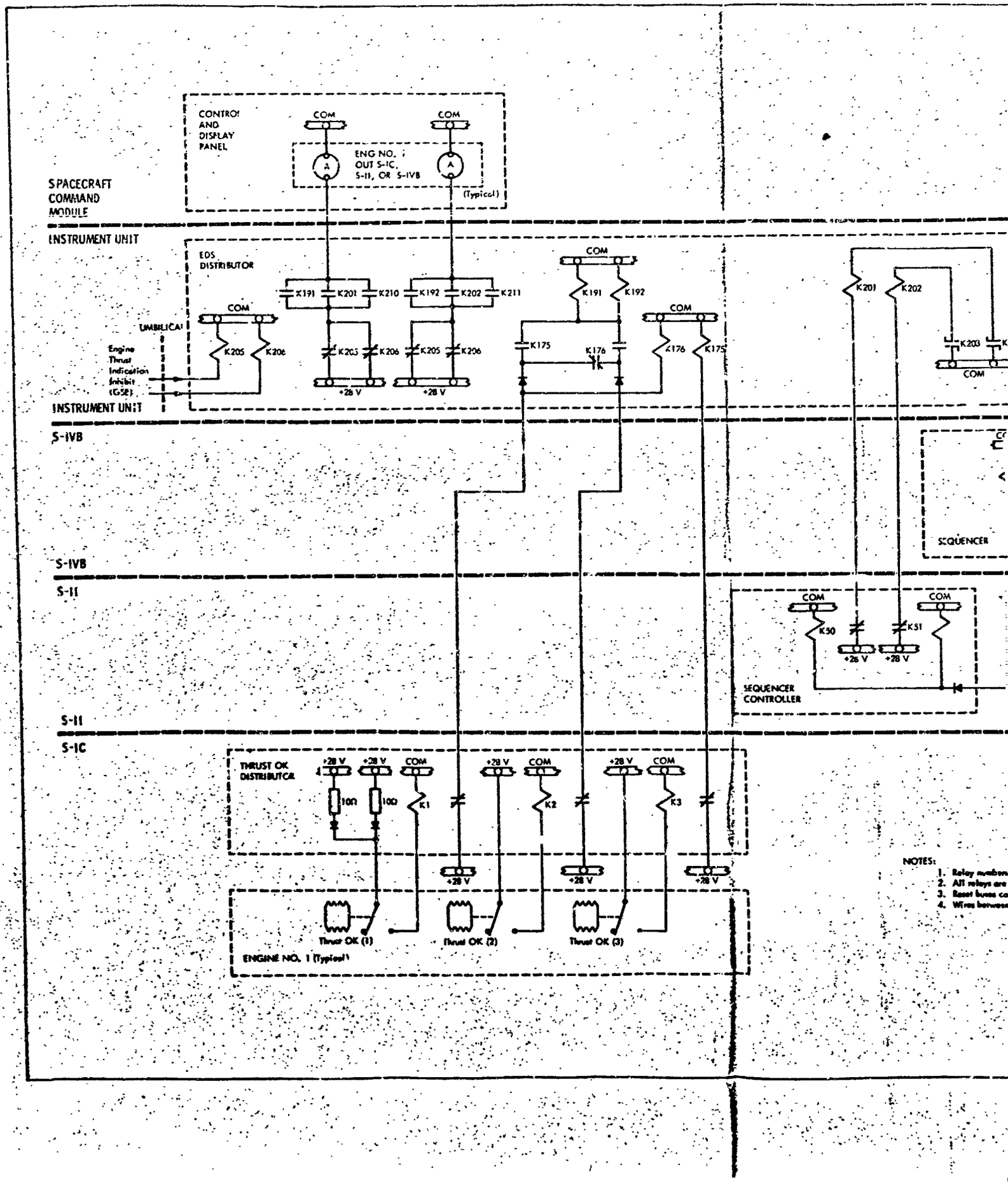
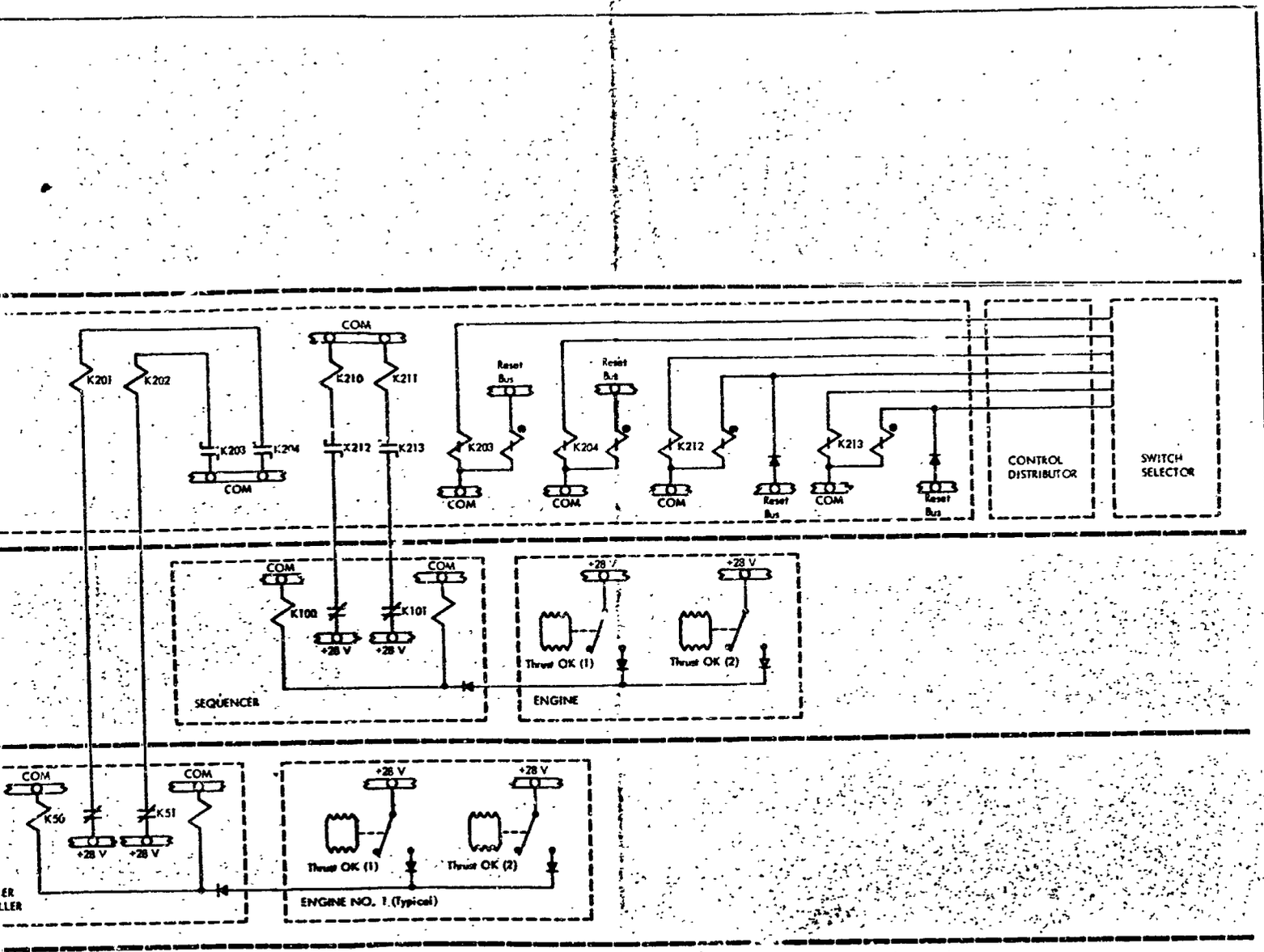


Figure 2-3. Angular Overrate Manual-Abort Indication Functional Schematic


SPACECRAFT COMMAND MODULE
CONTROL AND DISPLAY PANEL
COM
COM
ENG NO. 1 OUT S-IC, S-II, OR S-IVB
(Typical)
INSTRUMENT UNIT
EDS DISTRIBUTOR
K191
K201
K210
K192
K202
K211
K205
K206
K203
K175
K176
+28 V
UMBILICAL
Engine Thrust Indication Inhibit (GSE)
INSTRUMENT UNIT
S-IVB
SEQUENCER
S-II
K50
K51
SEQUENCER CONTROLLER
S-IC
THRUST OK DISTRIBUTOR
100Ω
K1
K2
K3
Thrust OK (1)
Thrust OK (2)
Thrust OK (3)
ENGINE NO. 1 (Typical)
NOTES:
1. Relay numbers
2. All relays are
3. Reset buses co
4. Wires between



NOTES:
1. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
2. All relays are shown in deenergized or reset condition.
3. Reset buses can be energized only from Ground Support Equipment.
4. Wires between Command Module and Instrument Unit pass through Service Module and Lunar Excursion Module adapter.

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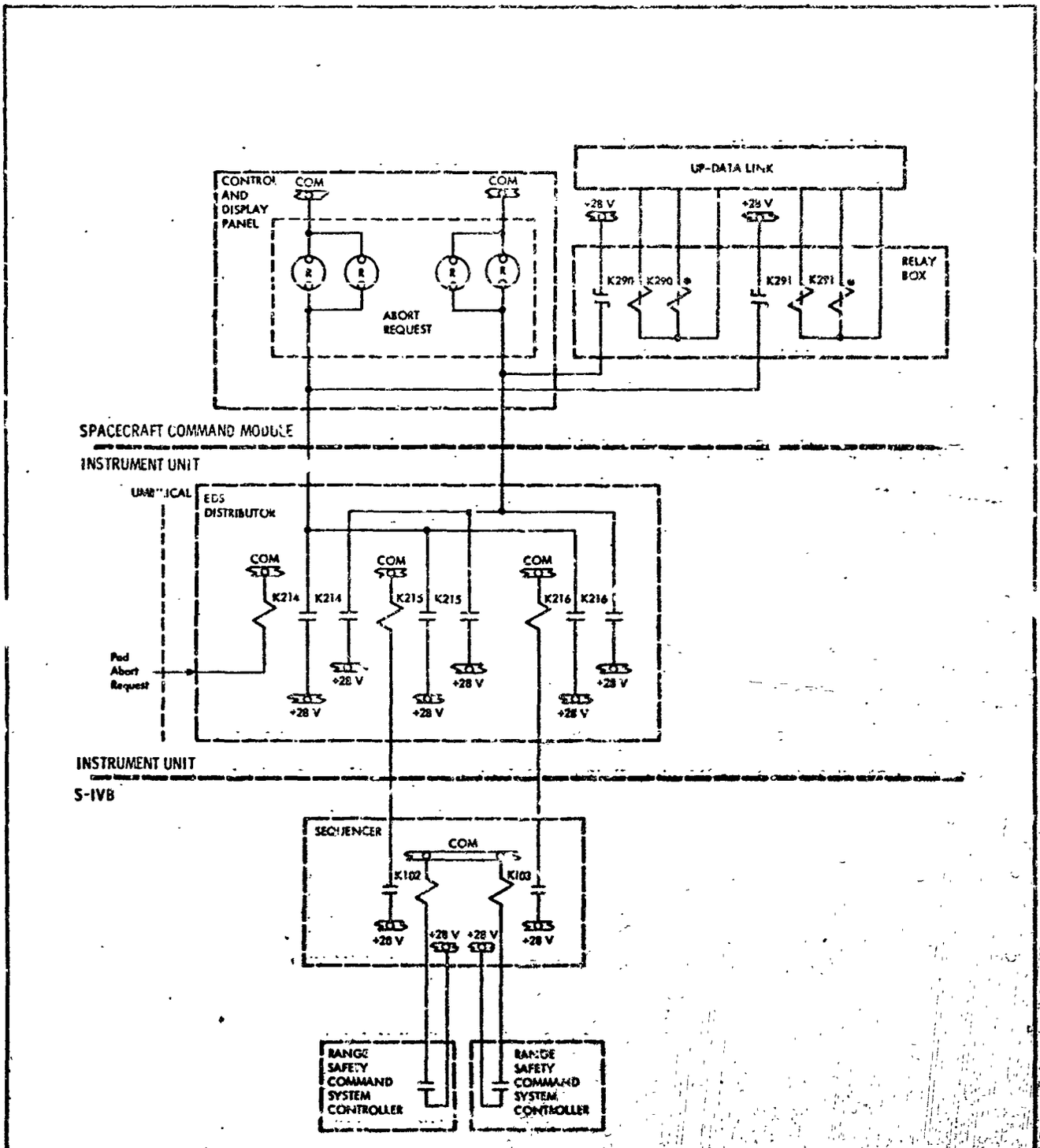
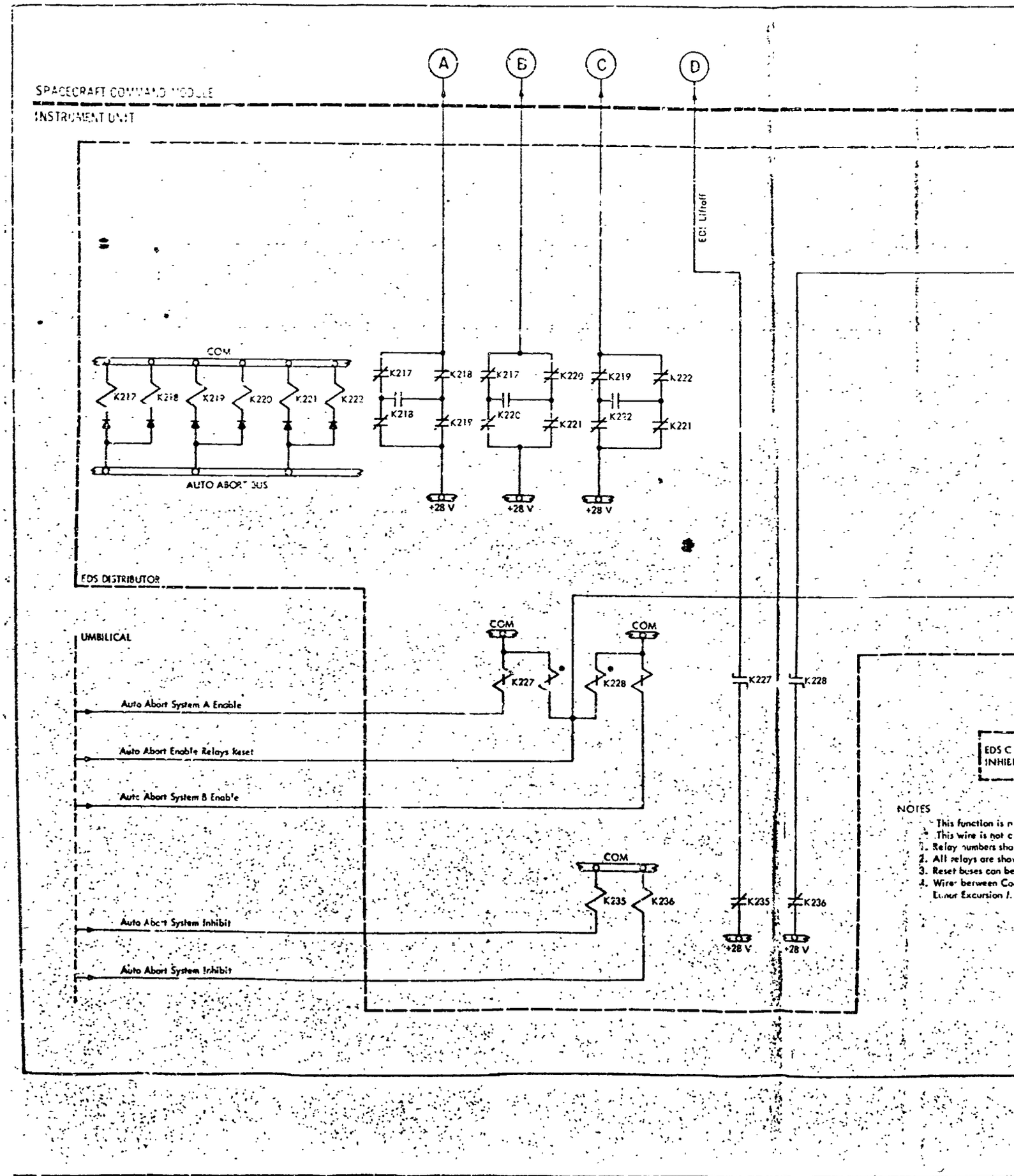
Figure 2-4. Engine Out Manual-Abort Indication Functional Schematic (Typical)



NOTES:

1. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
2. All relays are shown in deenergized or reset condition.
3. Wires between Command Module and Instrument Unit pass through Service Module and Lunar Excursion Module adapter.

Figure 2-5. Abort Request Indication Functional Schematic


A
Б
C
D
SPACECRAFT COMMAND MODULE
INSTRUMENT UNIT
EC: Liftoff
COM
K217
K218
K219
K220
K221
K222
AUTO ABORT BUS
+28 V
EDS DISTRIBUTOR
UMBILICAL
K227
K228
K235
K236
Auto Abort System A Enable
Auto Abort Enable Relays Reset
Auto Abort System B Enable
Auto Abort System Inhibit
Auto Abort System Inhibit
NOTES

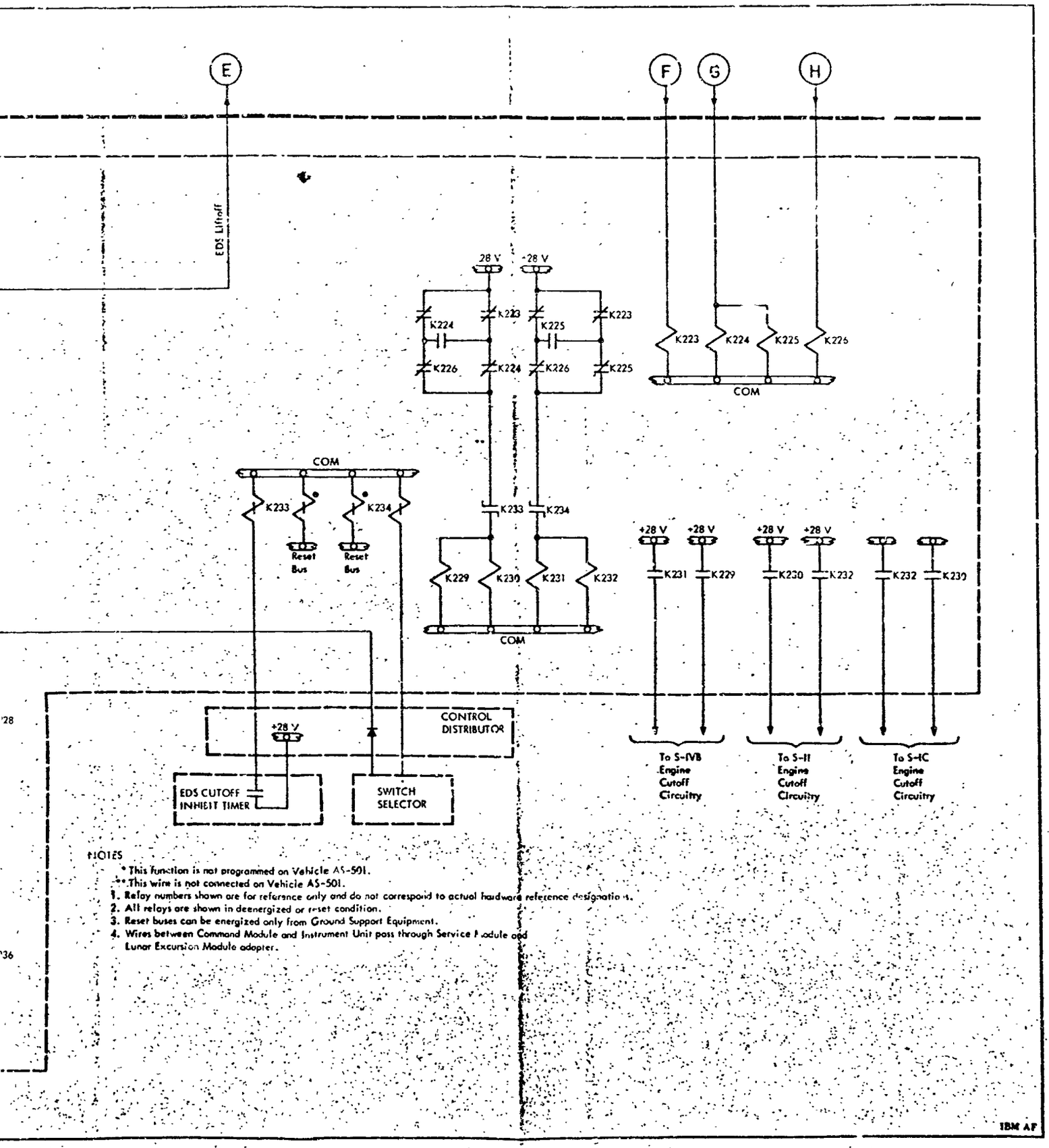
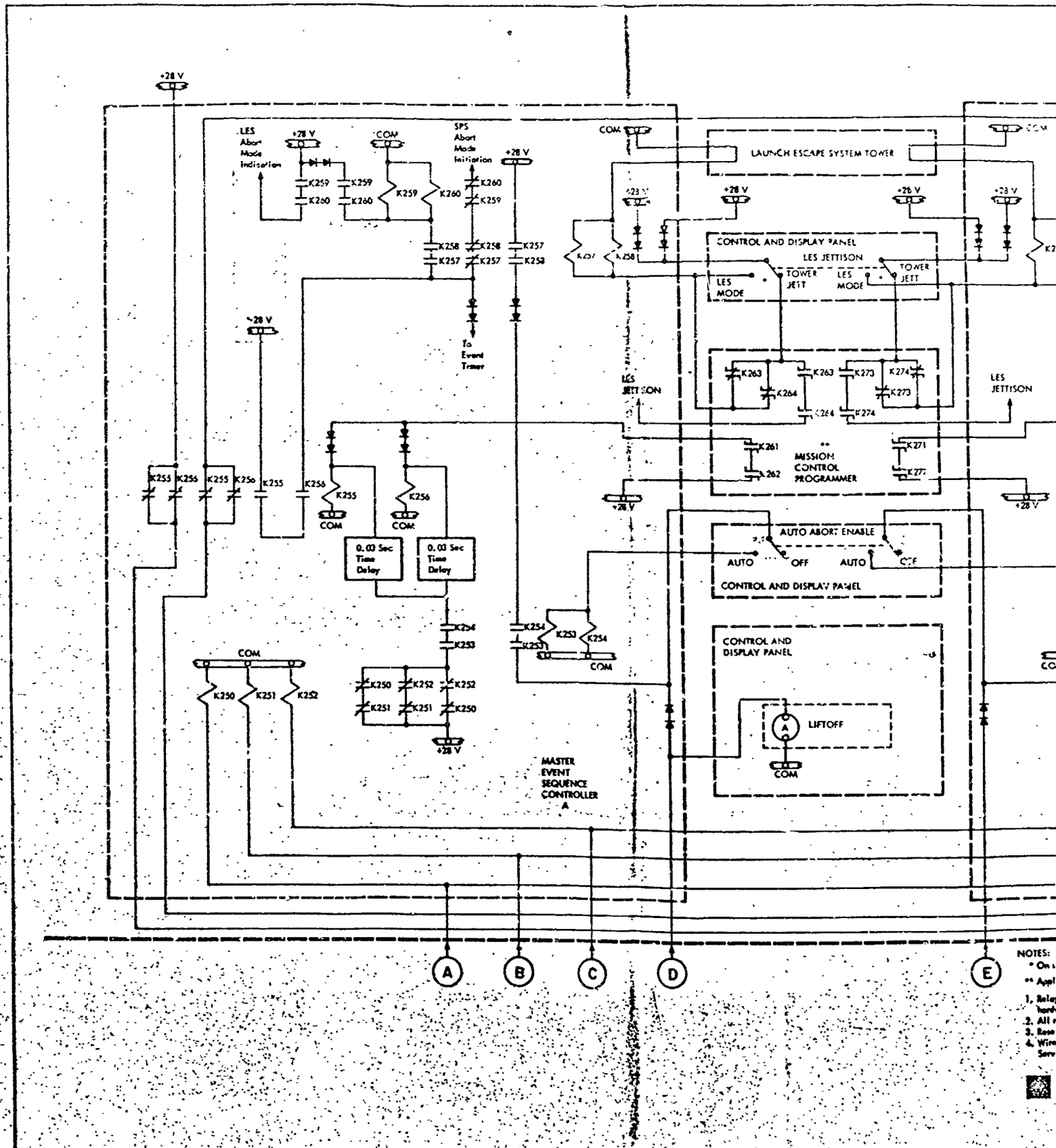


Figure 2-6. Abort Sequence Functional Schematic (Sheet 1 of 2)


+28 V
LES Abort Mode Indication
COM
SPS Abort Mode Initiation
K259
K260
K258
K257
To Event Timer
LAUNCH ESCAPE SYSTEM TOWER
CONTROL AND DISPLAY PANEL
LES JETTISON
LES MODE
TOWER JETT
K263
K264
K273
K274
K261
K262
K271
K272
MISSION CONTROL PROGRAMMER
AUTO ABORT ENABLE
AUTO
OFF
0.03 Sec Time Delay
K255
K256
K253
K254
K250
K251
K252
MASTER EVENT SEQUENCE CONTROLLER A
LIFTOFF
A
B
C
D
E

Figu

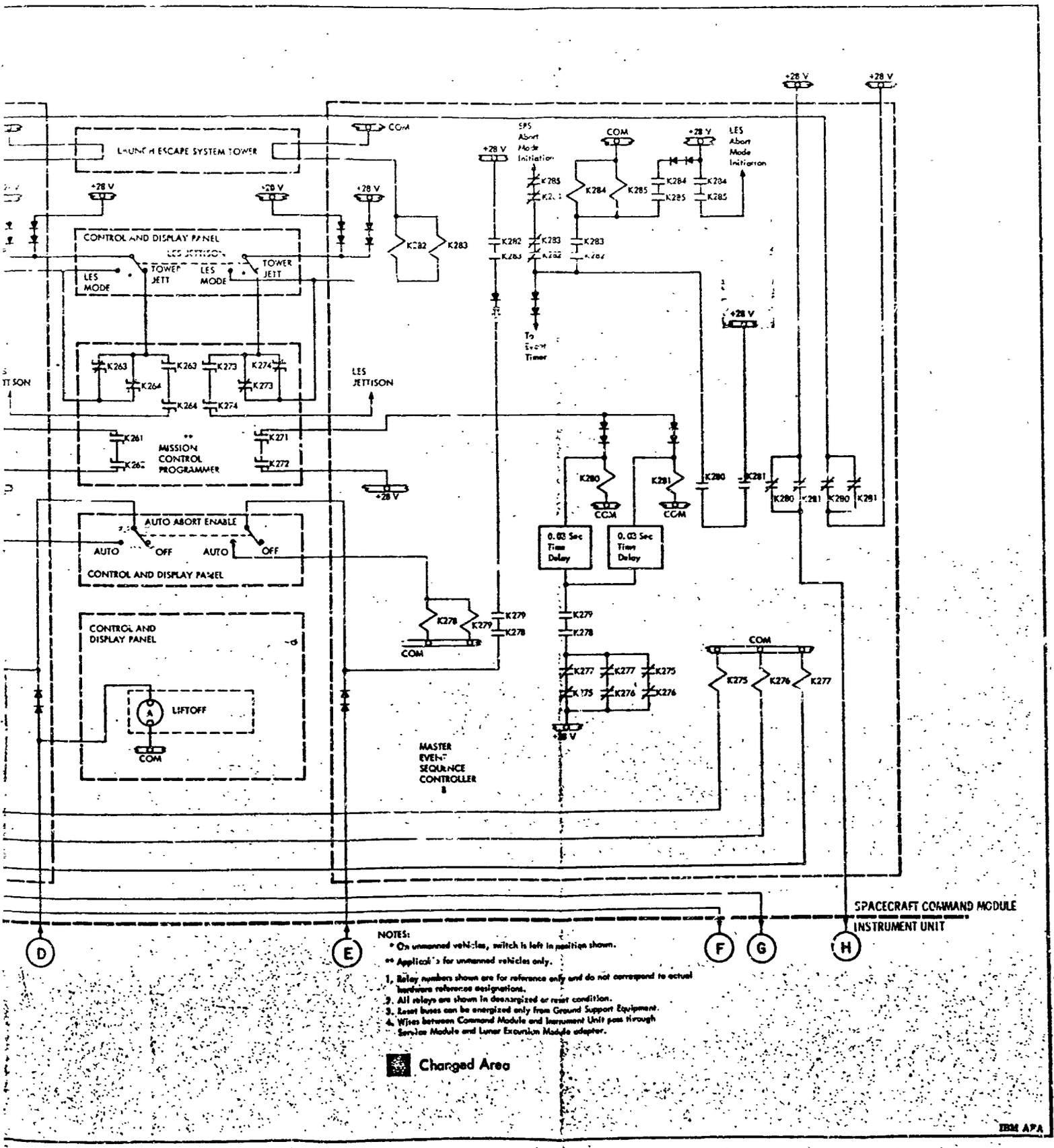
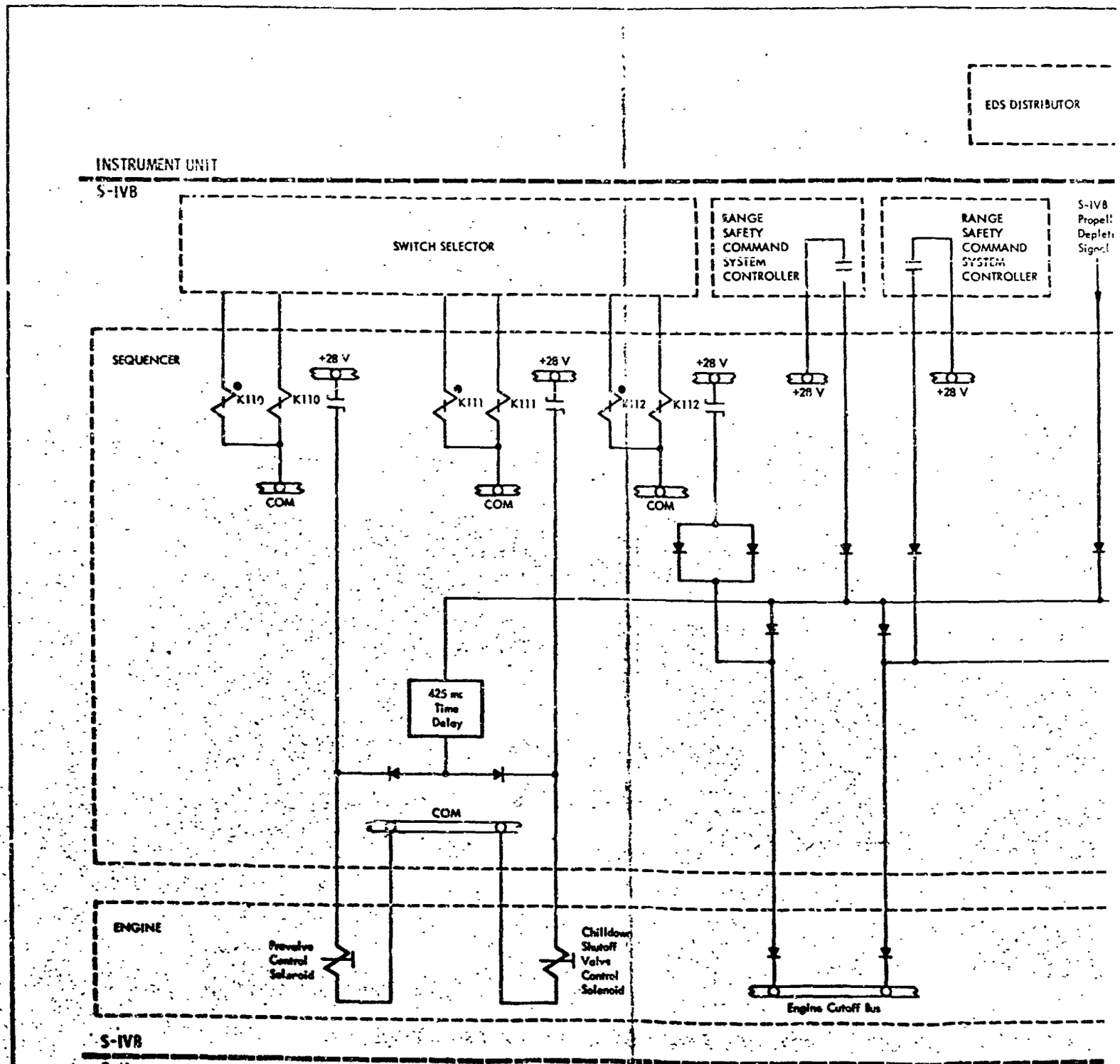


Figure 2-6. Abort Sequence Functional Schematic (Sheet 2 of 2)



NOTES:

1. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
2. All relays are shown in deenergized or reset condition.

Figure 2-7. S-IVB Engi

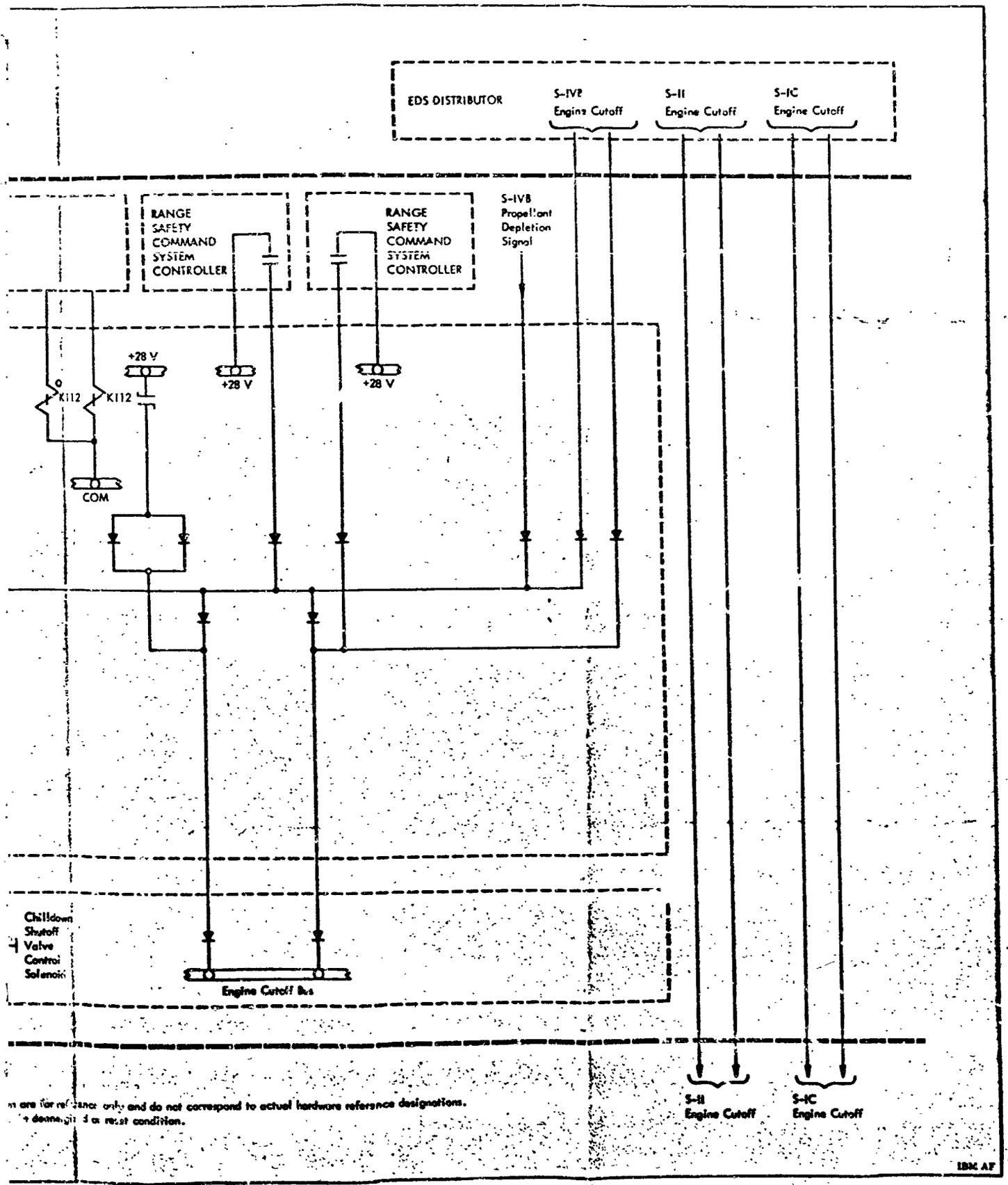
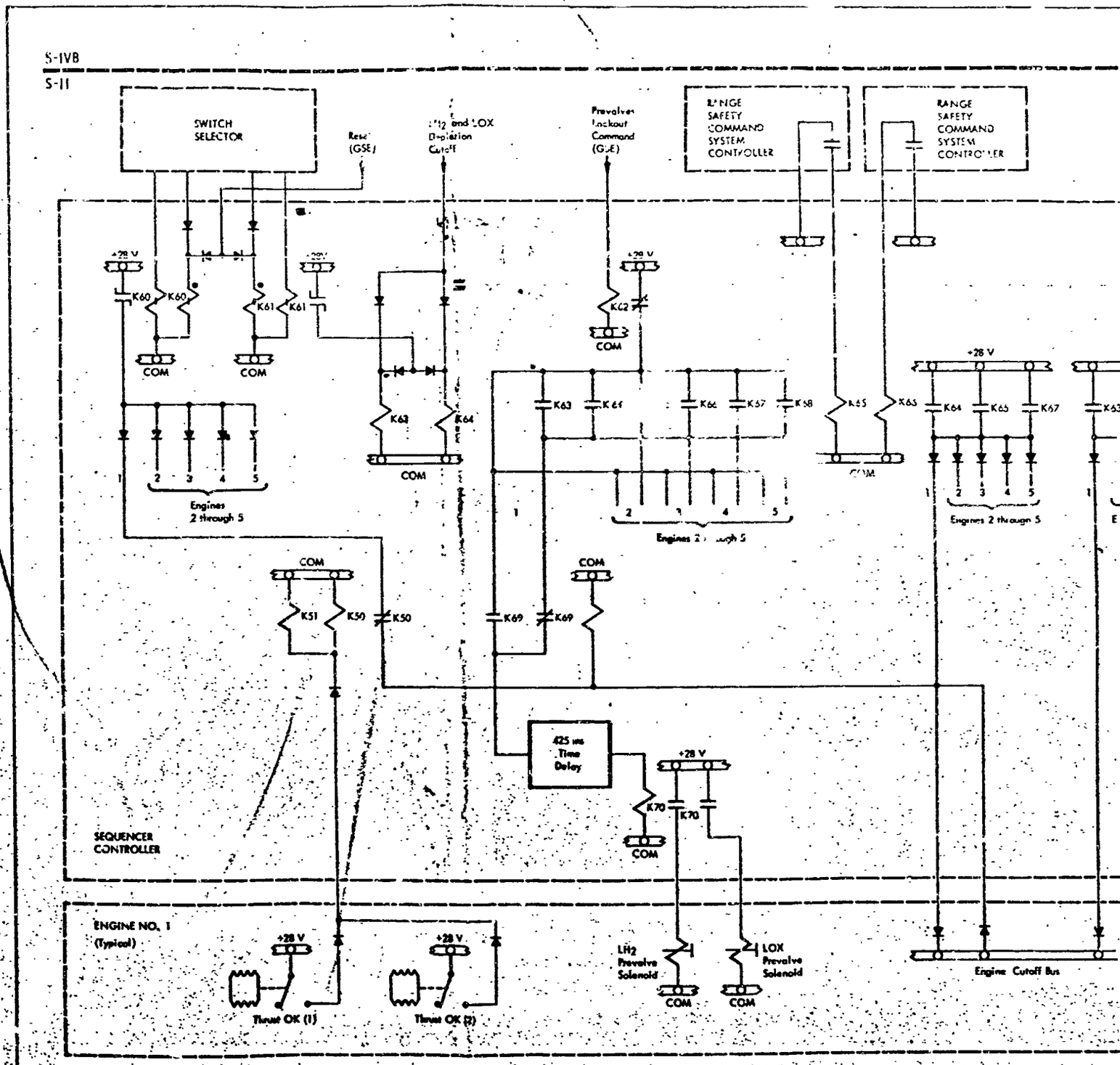


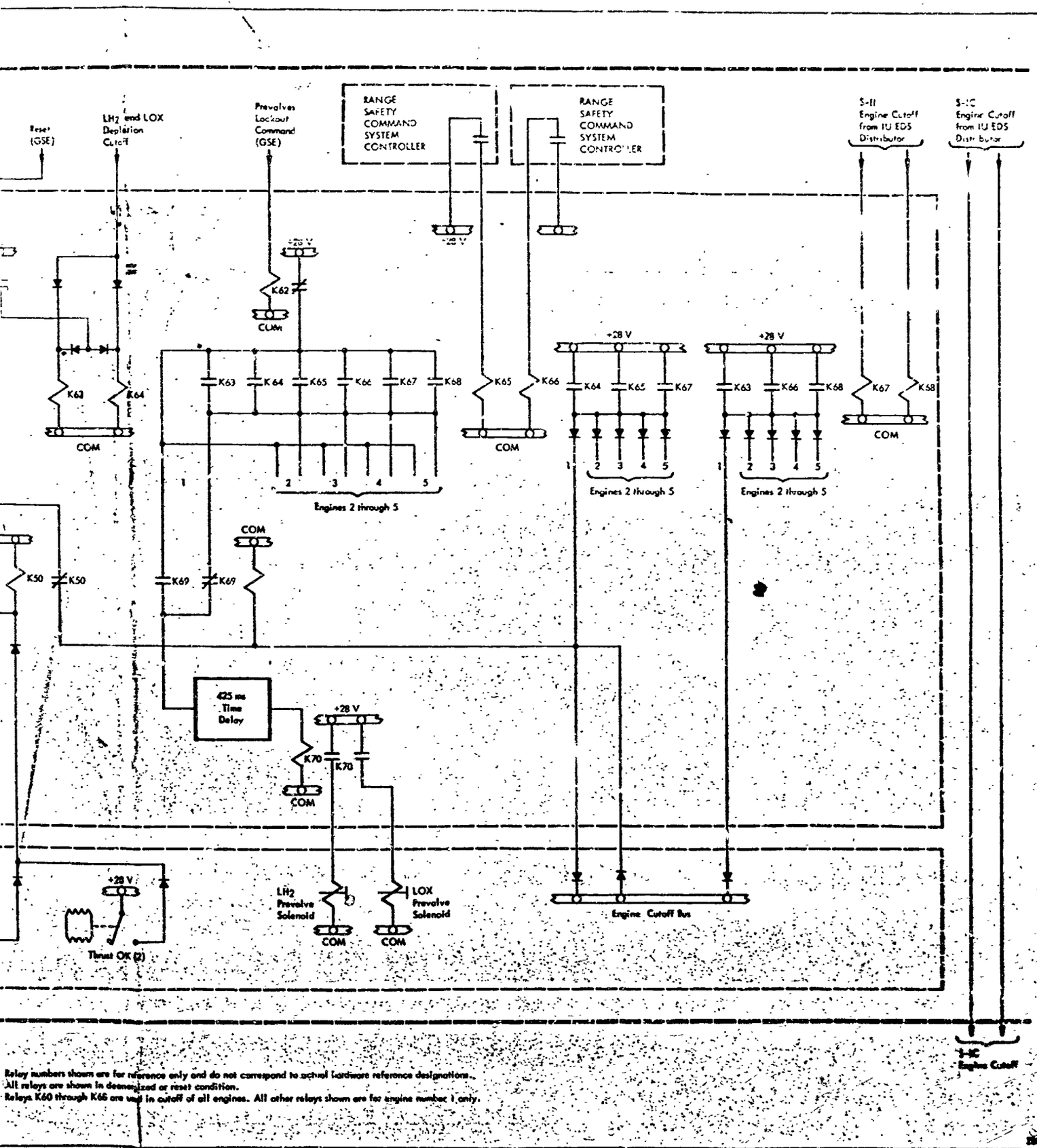
Figure 2-7. S-IVB Engine-Cutoff Functional Schematic



NOTES:

1. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
2. All relays are shown in deenergized or reset condition.
3. Relays K60 through K68 are used in cutoff of all engines. All other relays shown are for engine number 1 only.

Figure 2-8. S-II Engine-Cutoff Functional Sc



Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
All relays are shown in deenergized or reset condition.
Relays K60 through K66 are used in cutoff of all engines. All other relays shown are for engine number 1 only.

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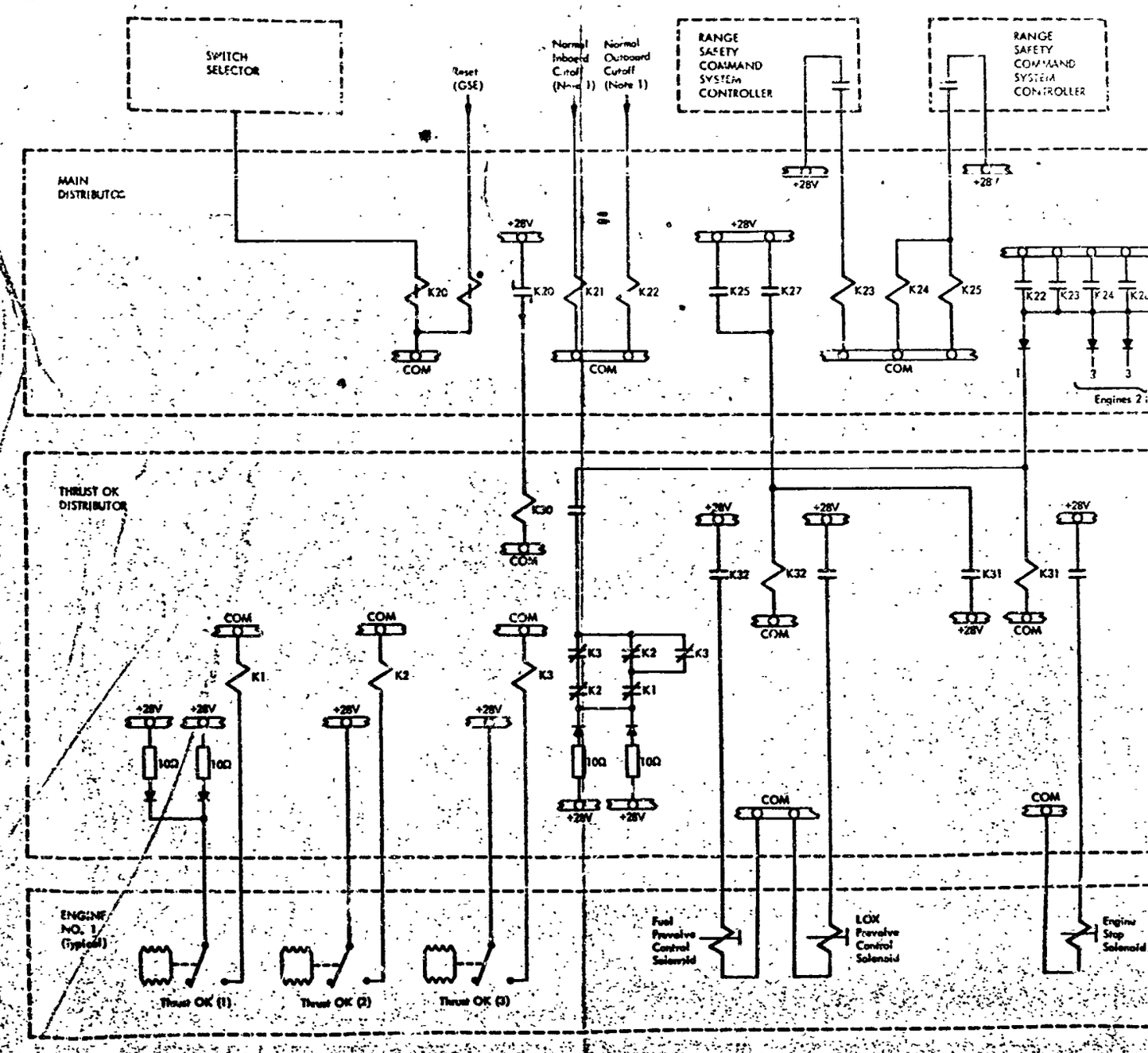
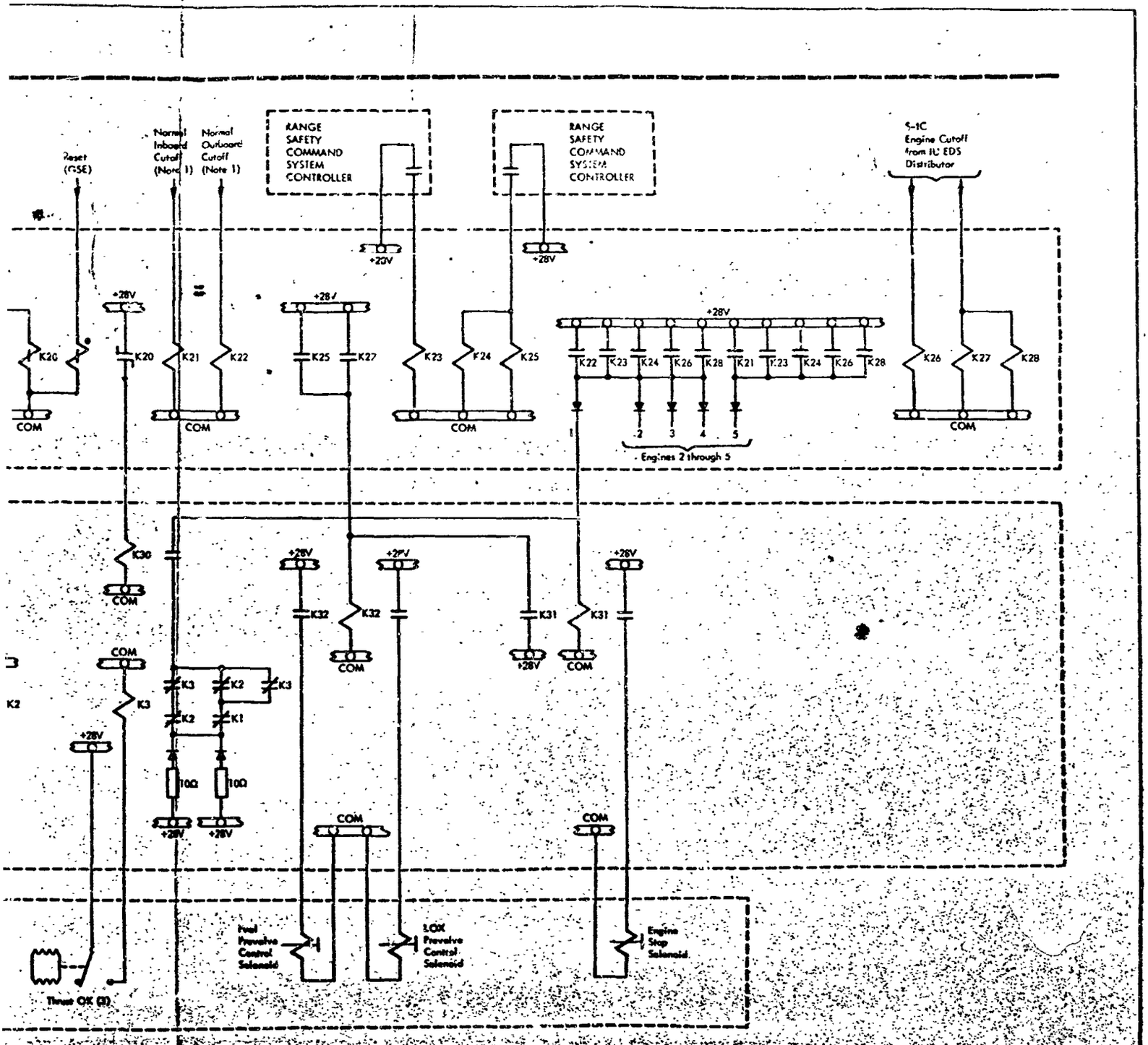
Figure 2-8. S-II Engine-Cutoff Functional Schematic (Typical)



NOTES:
1. Normal engine cutoff occurs when fuel level or LOX level falls to a preset minimum.
2. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
3. All relays are shown in deenergized or reset condition.
4. Relays K20, K23 through K28, and K30 are used in cutoff of all engines; relay K21 is used for inboard engine only, and relay K22 is used for the outboard engines only. All other relays shown are for engine number 1 only.

Figure 2-3. S-IC Engine-Cutoff



1. Normal engine cutoff occurs when fuel level or LOX level falls to a preset minimum.
2. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
3. All relays are shown in deenergized or reset condition.
4. Relays K30, K32 through K28, and K30 are used in cutoff of all engines; relay K21 is used for inboard engine only, and relay K22 is used for the outboard engines only. All other relays shown are for engine number 1 only.

1B66 AP

Figure 2-9. S-IC Engine-Cutoff Functional Schematic (Typical)

SECTION III
COMPONENT DESCRIPTIONS

This section presents a short description of each major EDS component. A major EDS component is defined herein as a component designed primarily for EDS use. Thus, those components that are involved in EDS operation but are normally considered as parts of other systems are not covered in this section.

3-1 EDS DISTRIBUTOR

The EDS Distributor (Figure 3-1) is located in the IU and provides the only communications link between the Spacecraft and the Saturn vehicle. The EDS Distributor serves as an enclosure for EDS relay logic circuitry, as well as a junction box for signals and power between the Spacecraft and the Saturn vehicle.

All EDS signals from the Saturn vehicle are routed to the logic circuits in the EDS Distributor. Output EDS signals from these logic circuits are then fed to the Spacecraft and to IU telemetry. Also, EDS signals from the Spacecraft are routed back through the EDS logic circuits before being fed to the S-IVB, S-II, and S-IC vehicle stages. The EDS Distributor

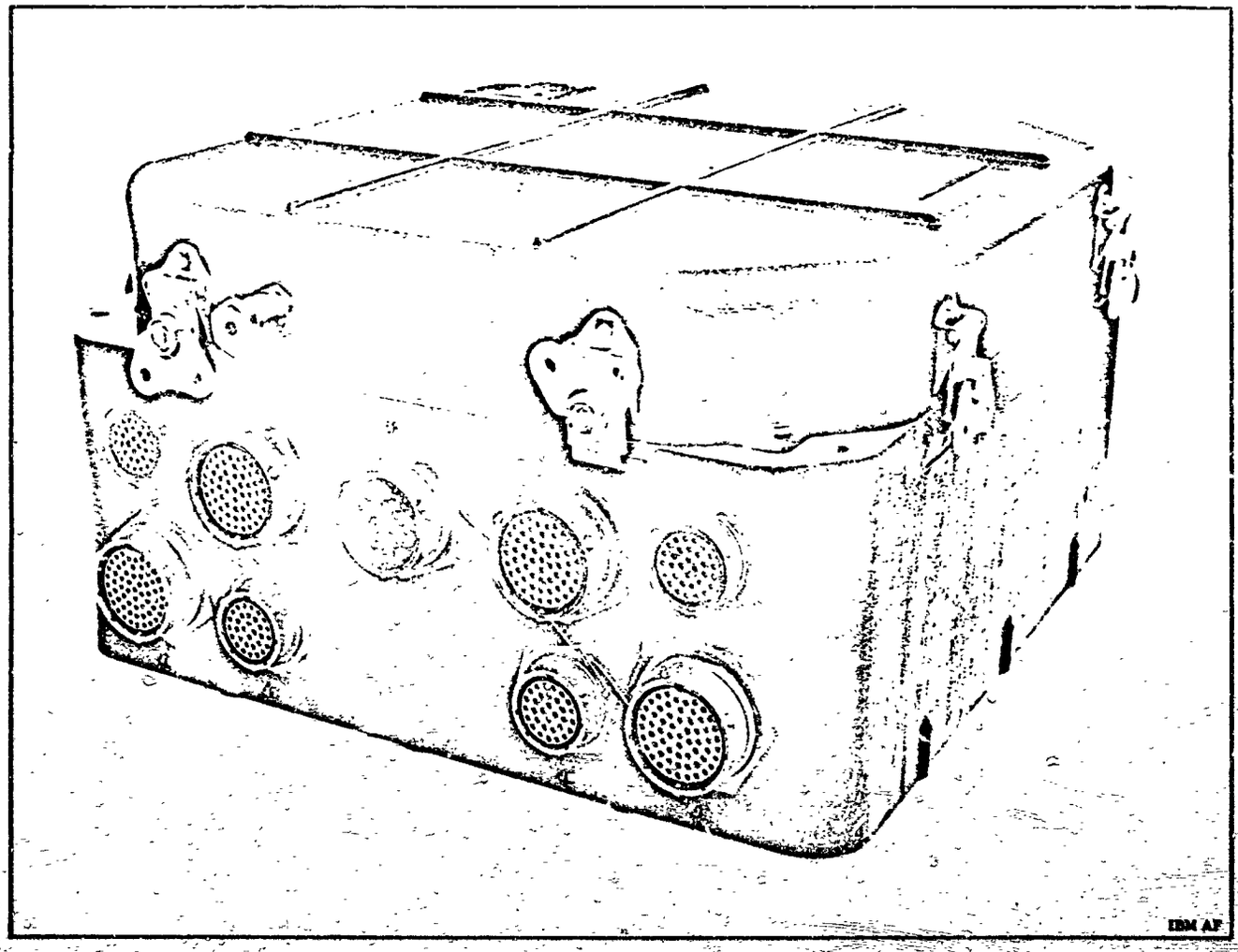


Figure 3-1. EDS Distributor

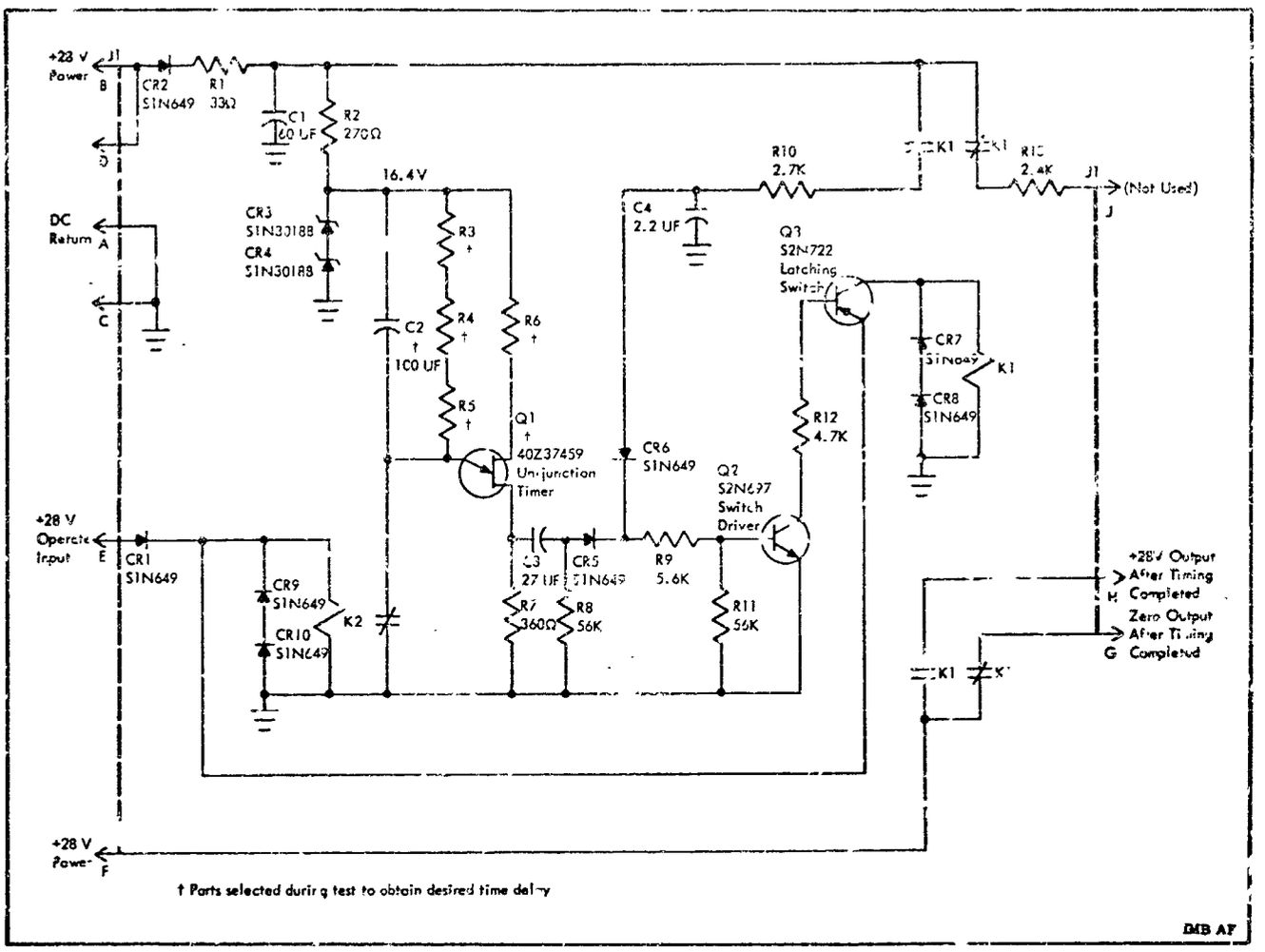


Figure 3-3. EDS Cutoff Inhibit Timer Schematic

A schematic of the timer appears in Figure 3-3. Initially, +28 V IU power is furnished to the timer at pins B and D of connector J1. This 28 V is applied to a filter composed of diode CR2, resistor R1, and capacitor C1. Any ac signal that might be present on the 28 V input is removed by this filter. After passing through the filter, the +28 V is applied to a voltage regulator circuit. The voltage regulator consists of resistor R2 and Zener diodes CR3 and CR4. Through the action of CR3 and CR4, the output of the voltage regulator is maintained at 16.4 V.

Output of the voltage regulator furnishes power for the timing circuit which is comprised of unijunction timer Q1, capacitor C2, and resistors R3 through R7. An RC timing network is made up primarily of selected parts C2, R3, R4, and R5. At the time the regulated voltage from R2 is initially applied to the RC network, relay K2 contacts are as shown on the schematic. Consequently, the emitter of Q1 is shorted to ground and C2 charges to the output voltage of the regulator. Until relay K2 is energized, Q1 will remain grounded and C2 will remain charged.

When the timing cycle of the EDS Cutoff Inhibit Timer is to begin (at liftoff), a +28 V input is applied to pin E of J1. This input is fed through isolation diode CR1 to energize relay K2. The +28 V input is also applied to the emitter of latching switch Q3. (Diodes CR9 and CR10 across K2 prevent damage to Q3 from transients created by K2.)

As K2 is energized, its contacts open. The grounding short is thereby removed from the emitter of Q1. Also, C2 is allowed to begin a slow discharge through R3, R4, and R5. While C2 is discharging, its output voltage opposes the output of the voltage regulator. Consequently, during C2 discharge, the resulting voltage appearing at the emitter of Q1 starts at zero potential and gradually rises. When this voltage rises to a sufficient positive value, Q1 conducts.

logic circuitry is described within the system description of Section II (Additional information can be found in the component manual for the EDS Distributor. Refer to the List of Related Documents.)

Connections to the EDS Distributor are made through several connectors on 2 sides of the case. Access to internal parts is obtained by removing the top and bottom covers. Most of the internal parts are mounted on circuit boards for ease of maintenance These parts are also encapsulated to prevent loosening during vibration.

The EDS Distributor weighs a maximum of 14.06 kilograms (31 pounds). The outside dimensions are as follows:

Length:	36.8 centimeters (14.5 inches) max
Width:	35.6 centimeters (14.0 inches) max
Height:	18.8 centimeters (7.4 inches) max

3-? EDS CUTOFF INHIBIT TIMER

A time delay is generated for the EDS by the EDS Cutoff Inhibit Timer (Figure 3-2). The time delay prevents an abort-sequence cutoff of the S-IC engines until after the vehicle has cleared the launch area. The EDS Cutoff Inhibit Timer is actuated at liftoff and produces an output after a predetermined time delay. The time delay is dependent upon mission requirements.

The EDS Cutoff Inhibit Timer (located in the IU) weighs a maximum of 0.2 kilogram (0.5 pound). The case of the timer is cast from magnesium alloy and has the following outside dimensions:

Length:	11.7 centimeters (4.6 inches) max
Width:	6.6 centimeters (2.6 inches) max
Height (with connector):	4.3 centimeters (1.7 inches)

With the exception of a connector and 2 relays, all circuit parts of the timer are mounted on a printed-circuit board. The circuit board and its parts are coated with a layer of polyurethane. After all circuit parts have been installed in the case of the timer, all remaining voids in the case are filled with polyurethane foam. A fiberglass bottom plate is embedded in the foam and prevents repair of the timer.

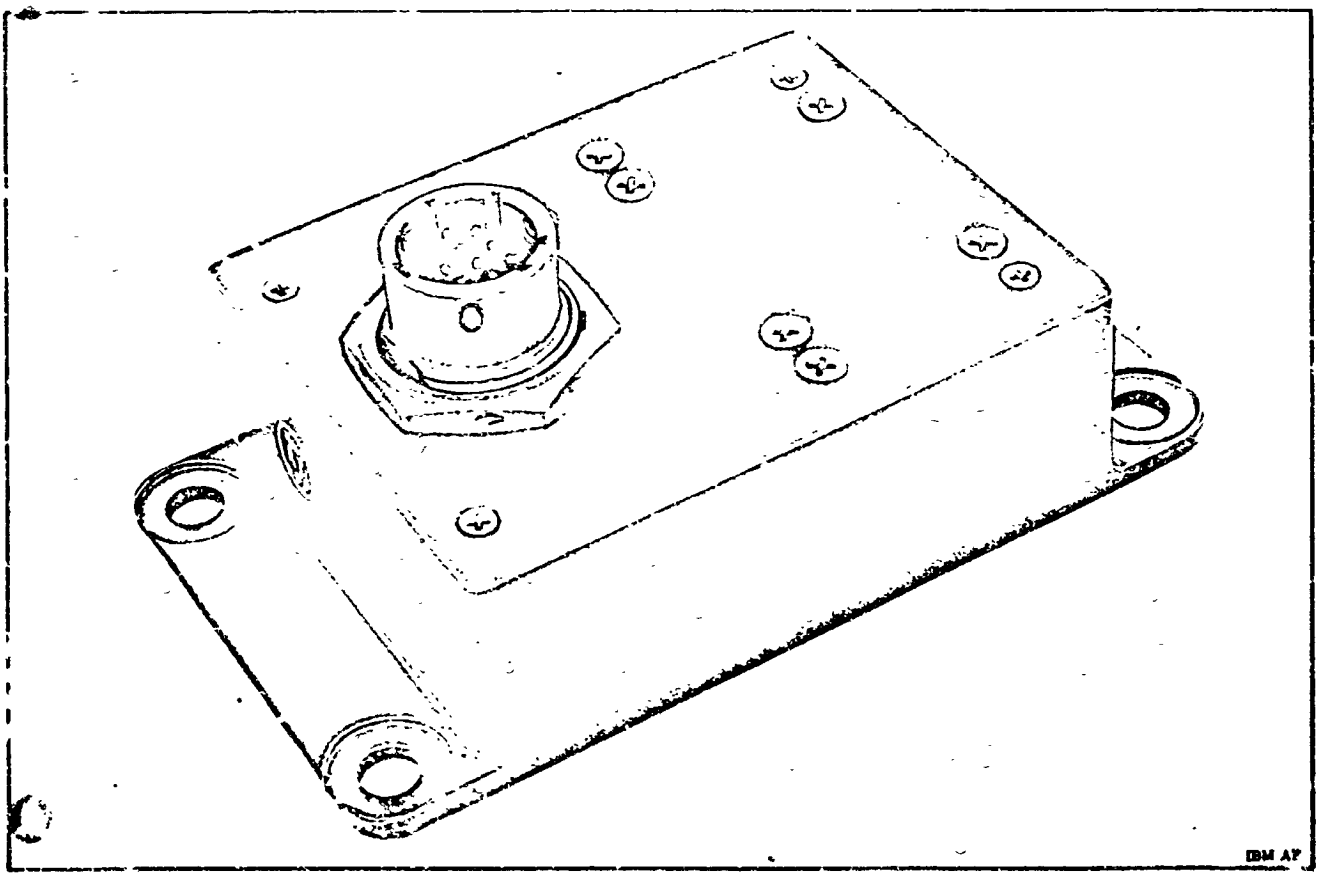


Figure 3-2. EDS Cutoff Inhibit Timer

The time interval between the opening of the K2 contacts and the conduction of Q1 is dependent upon Q1, the value of R6, and the values of the components in the RC network. Therefore, Q1, C2, and R3 through R6 must be preselected to obtain a desired time interval.

When Q1 conducts, C2 stops discharging and immediately begins to recharge rapidly through Q1 and R7. This action produces a positive pulse across R7. The pulse is applied to switch driver Q2 through coupling capacitor C3, isolation diode CR5, and current limiting resistor R9. Upon application of the pulse to Q2, Q2 conducts and causes latching switch Q3 to conduct. (Both Q2 and Q3 are driven to saturation.) Conduction of Q3 energizes relay K1. (Diodes CR7 and CR8 across K1 prevent K1 transients from damaging Q3.)

With K1 energized, +28 V from the filter network (R1 and C1) is fed through a set of now closed contacts of K1 to current limiting resistor R10. From R10, a positive voltage is applied to Q2 through isolation diode CR6 and resistor R9. Since this voltage is constant while K1 is energized, Q2 is maintained in conduction. Consequently, Q3 remains in conduction and K1 remains energized. Relay K1 will stay in the energized condition until removal of the +28 V input applied to the emitter of Q3 (through pin E of J1).

Relay K1 contains 2 sets of Normally Closed (NC) contacts and 2 sets of Normally Open (NO) contacts. The NC contacts are not used in the EDS Cutoff Inhibit Timer for external EDS circuits (however, refer to paragraph 3-3). One set of the NO contacts is utilized as described in the preceding paragraph. The other set of NO contacts applies +28 V through pin H of J1 to an external EDS circuit.

3-3 EDS OVERRATE TIMER

A time delay generated by the EDS Overrate Timer is used in making an in-flight change to EDS angular overrate limits. This EDS Timer is actuated at liftoff and produces an output 20 (+0.6, -0.2) seconds after being actuated.

With one exception, the EDS Overrate Timer is physically and functionally identical to the EDS Cutoff Inhibit Timer (paragraph 3-2). The one exception is in the timing RC network. For the EDS Overrate Timer, the values of the RC network resistors are selected so that the discharge time of capacitor C2 will cause relay K1 to be energized 20 (+0.6, -0.2) seconds after relay K2 is energized.

Unlike the EDS Cutoff Inhibit Timer, the output of the EDS Overrate Timer is taken from 1 set of the NC contacts of relay K1 (pin G of J1). Therefore, a +28 V output is removed from an external EDS circuit when K1 is energized.

3-4 EDS Q-BALL SENSOR SYSTEM

Known as the Q-Ball, the EDS Q-Ball Sensor System (Figure 3-4) produces outputs that are displayed on meters as pressure differentials but are interpreted as indications of vehicle angle of attack. The Q-Ball operates on the principle of detecting differences in aerodynamic pressures; hence, the abbreviation for dynamic pressure, or Q, in the name. One of the Q-Ball outputs is furnished to the Command Module for display; the other outputs are supplied to TM equipment for transmission to ground.

The Q-Ball (including all its electronic parts) is enclosed in a smooth outer shell, which forms the forward tip of the LES. The combined weight of the Q-Ball and its shell is 15.9 kilograms (35 pounds). The length of the shell is 33.8 centimeters (13.3 inches), and the diameter at the aft end of the shell is 31.8 centimeters (12.5 inches).

To prevent contamination of the Q-Ball prior to launch, a fiberglass cover is placed over the top of the Q-Ball. A nylon bladder is installed between the cover and the Q-Ball, and a lanyard is connected from the top of the cover to a retracting mechanism on the umbilical tower. When the cover is to be removed, the nylon bladder is pressurized with GN_2 through a hose from the tower. As the bladder expands, it raises the cover. The retracting mechanism then pulls the lanyard to remove the cover from the Q-Ball.

Because of its physical location on the LES, the Q-Ball is not affected during flight by the air turbulence normally caused by the vehicle. Also, at this location, the Q-Ball is at the greatest distance forward of the vehicle pitch and yaw rotational axes. Thus, when the angle of attack is changing, the Q-Ball can more easily and accurately measure the aerodynamic pressure differentials at the forward end of the vehicle. The differences in aerodynamic pressures, imposed on opposite sides of the Q-Ball outer shell, are used in determining the vehicle angle of attack.

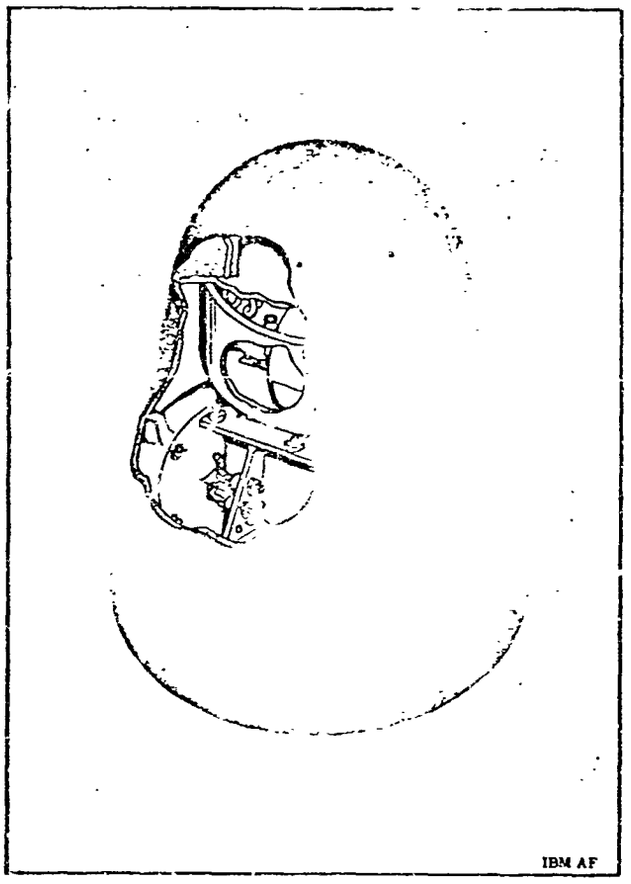


Figure 3-4. EDS Q-Ball Sensor System

The Q-Ball is divided functionally into two independent but almost identical channels. An output from either channel can be used to determine the vehicle angle of attack. Each channel obtains aerodynamic pressure inputs through separate pressure inlet ports. Eight such ports are located around the perimeter and near the forward end of the Q-Ball outer shell (Figure 3-4).

Two ports on opposite sides of the shell lie in the pitch plane of the vehicle (Figure 3-5). Likewise, two ports on opposite sides of the shell lie in the yaw plane. The two pitch inlet ports provide pressure inputs to a pitch differential pressure transducer in channel A of the Q-Ball. Similarly, the two yaw ports provide pressure inputs to a yaw differential pressure transducer in channel A. Channel B of the Q-Ball obtains pressure inputs from four similar inlet ports. However, the ports for channel B are offset 45 degrees from the true pitch and yaw planes of the vehicle.

A differential pressure signal is derived from the output of each differential pressure transducer in the Q-Ball. The signals derived from the pitch and yaw transducers in channel A are combined in a summing circuit within that channel. Differential pressure signals in channel B are also combined in a summing circuit. The output from each summing circuit represents the vector sum (magnitude, not direction) of the differences in aerodynamic pressures acting on the sides of the vehicle. Figure 3-5 vectorially shows the summing in each channel.

The vector sum signal from Q-Ball channel A is displayed on a meter in the Command Module. The vector sum signal from channel B is not displayed, but is fed through the EDS Distributor in the IU to TM equipment. Separate pitch and yaw differential pressure signals from channel A are fed directly to TM equipment in the IU. When displayed, pressure differential signals from the Q-Ball are interpreted as indications of the vehicle angle of attack.

3-5 LAUNCH ESCAPE SYSTEM

Sometimes called the Launch Escape Tower, the Launch Escape System (Figure 3-6) provides the thrust necessary to pull the Command Module free of a malfunctioning vehicle. The LES normally remains with the Apollo-Saturn vehicle until shortly after S-II engine ignition. Up to this time in the flight, the vehicle acceleration is low enough that the thrust of the LES is sufficient to pull the Command Module away from the vehicle if it becomes necessary. When no longer needed, the LES is jettisoned either automatically by the flight sequencing circuits of the vehicle or manually by the crew.

The LES consists essentially of three separate solid-propellant rocket motors, two canard surfaces, a tower structure, and the apex section of a boost protective cover (Figure 3-6). Although not a functional part of the LES, the EDS Q-Ball Sensor System is mounted at the forward tip of the LES. All control of the LES rocket motors and canard surfaces originates from within the Command Module.

One of the LES rocket motors, the largest of the three, is the main launch escape motor that provides the thrust for an LES abort. The launch escape motor has 4 nozzles canted outward. A second motor, with 2 nozzles on opposite sides of the LES, is the LES jettison motor for removing the LES from the Command Module. The third motor is the pitch control motor, with a single nozzle on one side of the LES. This motor causes the LES/Command-Module combination to pitch over during a low-altitude abort.

The two canard surfaces near the forward end of the LES are automatically deployed approximately

11 seconds after ignition of the main launch escape motor. These surfaces cause and then damp a turn-round maneuver during a medium-altitude abort. This maneuver ensures that the blunt end of the Command Module will face downward during descent. During an LES high-altitude abort, the LES is jettisoned by the crew before the canards can be deployed. In this case, the Command Module Reaction Control System is used to cause and damp the turn-around maneuver.

A tower structure physically connects the body of the main launch motor to the top of the Command Module and to the boost protective cover. The boost protective cover consists of a rigid apex section and a flexible aft section (the aft section is not shown in Figure 3-6). The cover completely surrounds the top and sides of the Command Module. At LES jettison, the complete boost protective cover is pulled from the Command Module.

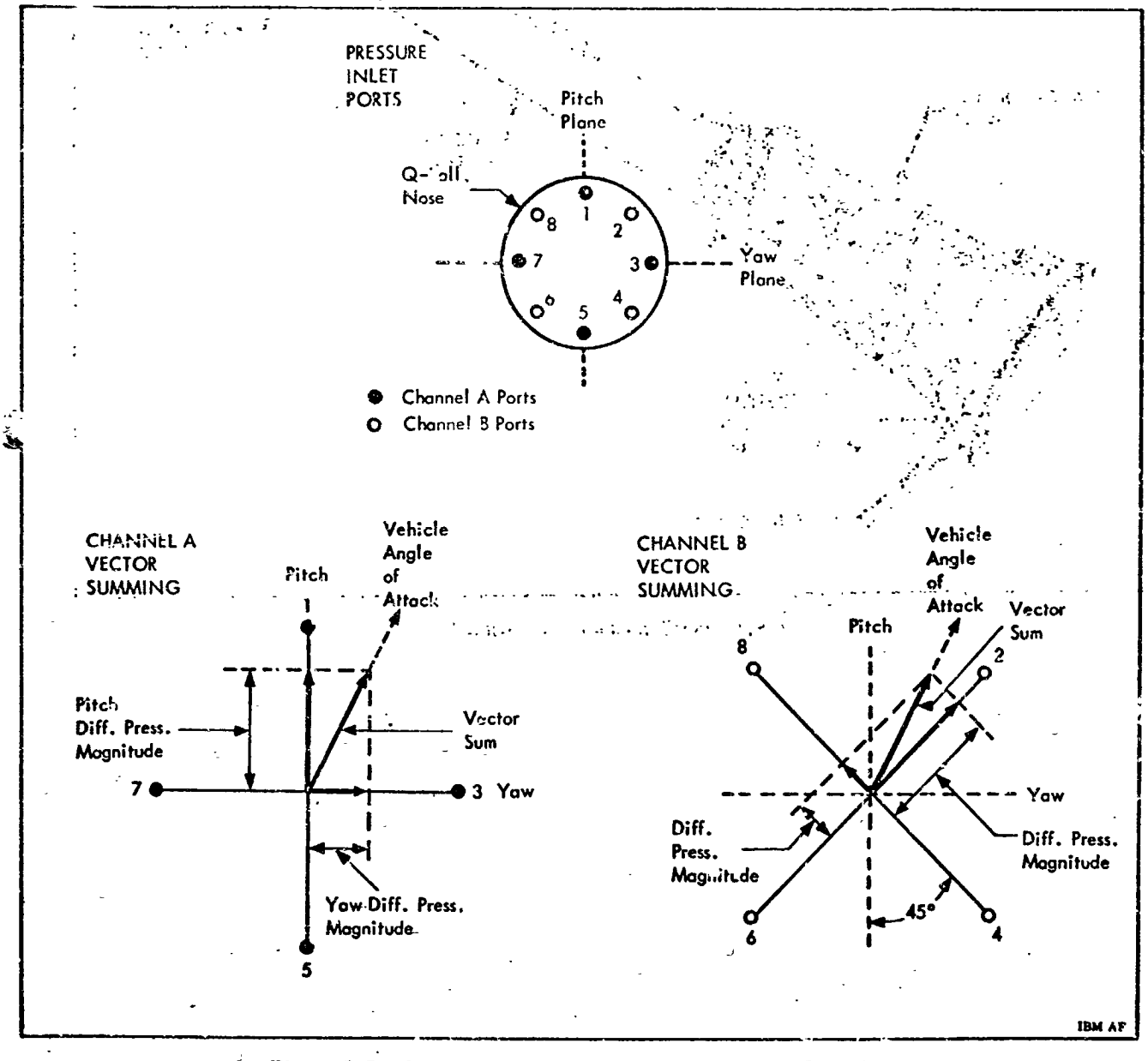


Figure 3-5. Q-Ball Pressure Inlet Ports and Vector Summing

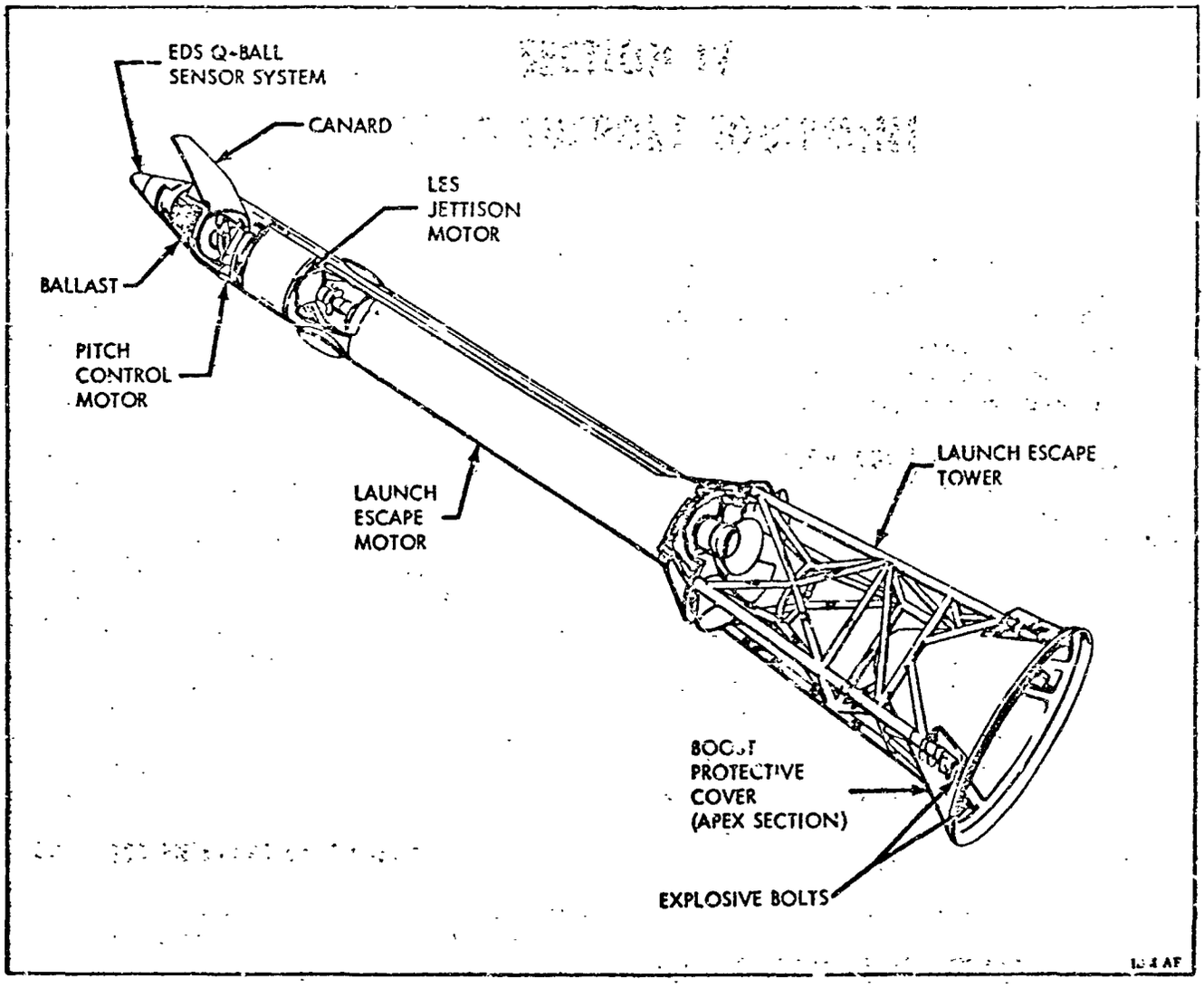


Figure 3-6. Launch Escape System

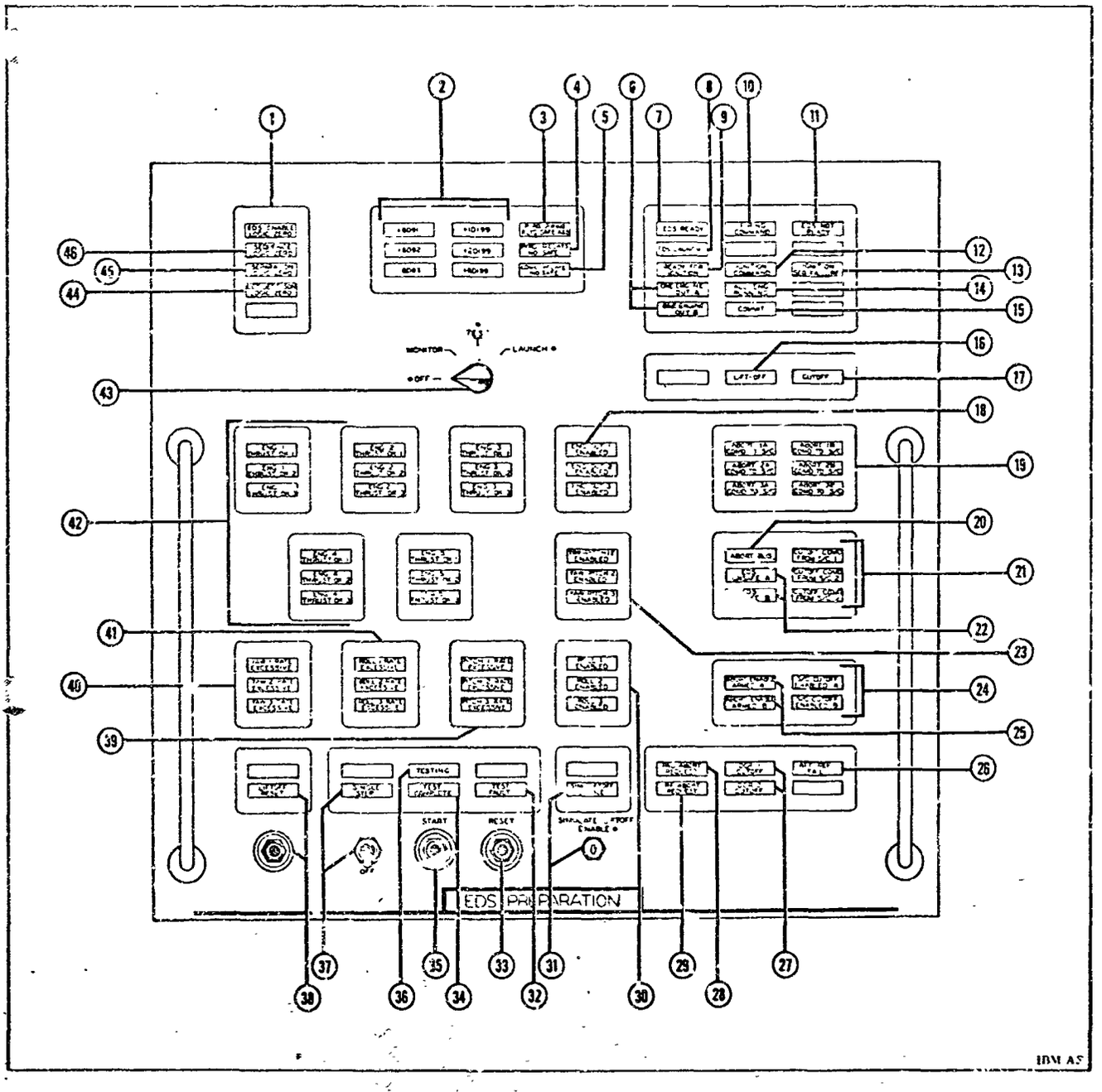


Figure 4-1. EDS Preparation Panel

Legend for Figure 4-1

Index Number	Control or Indicator	Function
1	EDS ENABLE LOGIC ZERO	Indicates that no inhibit signal has been received from the IU Switch Selector to inhibit either an angular-overrate or two-engine-out automatic abort.
2	6D91, 6D92, 6D93, 1D199, 2D199, and 6D199	Indicate that the respective busses are energized.

Legend for Figure 4-1 (Cont)

Index Number	Control or Indicator	Function
3	PYRO FIRING RLYS SAFE A & B	Indicates that pyrotechnic relays in the Command Module are deenergized.
4	PYRO RELAYS IND SAFE	Indicates that neither pyrotechnic bus in the Command Module has been energized.
5	LOGIC RELAYS IND SAFE	Indicates that the logic relays in the Command Module are deenergized.
6	ONE ENG OUT A & B	Indicates that at least one S-IC engine is out (duplex circuits)
7	EDS READY	Indicates that all EDS circuits are ready for normal operation and no unsafe conditions are present.
8	EDS LAUNCH	Indicates that the Function switch (index number 43) has been set to LAUNCH or a firing command has been given.
9	READY FOR IGNITION	Indicates that the Saturn vehicle is ready for ignition.
10	FIRING COMMAND	Indicates that the Saturn firing command has been issued.
11	EDS NOT READY	Indicates that at least one of several EDS circuits is in an unsafe condition.
12	IGNITION COMMAND	Indicates that the ignition command for the S-IC engines has been issued.
13	IGNITION SEQ FAILURE	Indicates that a failure has occurred in the S-IC engine ignition sequence.
14	ALL ENG RUNNING	Indicates that all S-IC engines are producing proper thrust.
15	COMMIT	Indicates that the Apollo-Saturn vehicle has been released and is ready to leave the launch pad.
16	LIFTOFF	Indicates that the vehicle has lifted off the launch pad.
17	CUTOFF	Indicates that the S-IC engines have been cutoff before the vehicle has been committed to launch.
18	ENG OUT ENABLED 1, 2, and 3	Indicates that an automatic abort, resulting from a two-engine-out condition, has not been inhibited in the EDS Distributor. (One indicator light for each inhibiting relay.)

Legend for Figure 4-1 (Cont)

Index Number	Control or Indicator	Function
19	ABORT COMD TO S/C 1A, 1B, 2A, 2B, 3A, and 3B	Indicate that six automatic abort initiate relays in the EDS Distributor have been energized. These relays are energized either by the auto abort bus in the EDS Distributor or by the GSE checkout computer.
20	ABORT BUS	Indicates that the auto abort bus in the EDS Distributor has been energized.
21	CUTOFF COMD FROM S/C 1, 2, and 3	Indicate that the three engine-cutoff signals from the MESC's have been received by the EDS Distributor.
22	EDS UNSAFE A and B	Indicate that at least one of three automatic abort relays in each MESC has been deenergized. (Each indicator is controlled by the abort relays in one MESC only.)
23	YAW-PITCH ENABLED 1, 2, and 3	Indicate that an automatic abort, resulting from a yaw or pitch angular-overrate condition, has not been inhibited in the EDS Distributor. (One indicator light for each inhibiting relay.)
24	S/C CUTOFF ENABLED A and B	Indicate that engine cutoff has been enabled by the IU Switch Selector and by the EDS Cutoff Inhibit Timer, respectively.
25	ABORT ENABLE ARMED A and B	Indicate that the auto abort enable relays in the EDS Distributor have been energized (set) by the GSE checkout computer (duplex circuits).
26	ATTITUDE REF FAIL	Indicates that the EDS Distributor has received an attitude reference failure signal from the Saturn Guidance System.
27	DCR CUTOFF 1 and 2	Indicate that both Range Safety (Destruct) Command Receivers in the S-IVB Stage have initiated S-IVB engine cutoff.
28	PAD ABORT REQUEST	(Not used)
29	RF ABORT REQUEST	Indicates that an abort request has been transmitted to the Spacecraft from the ground.
30	ROLL ENABLED 1, 2, and 3	Indicate that an automatic abort, resulting from a roll angular-overrate condition, has not been inhibited in the EDS Distributor. (One indicator light for each inhibiting relay.)

Legend for Figure 4-1 (Cont)

Index Number	Control or Indicator	Function
31	SIM LIFTOFF ENABLE	Enables a simulated liftoff signal to be initiated by other GSE checkout units, which can deenergize liftoff relays in the EDS Distributor. (SIM LIFTOFF ENABLE switch is key operated. Indicator light immediately above switch indicates that switch is ON.)
32	TEST FAULT	Indicates that the GSE automatic test program has stopped due to detection of a fault.
33	RESET	Resets GSE test program to continue after a failure occurs.
34	TEST COMPLETE	Indicates that the GSE automatic test of the EDS has been completed.
35	START	Starts GSE automatic test of EDS.
36	TESTING	Indicates that the GSE automatic test of the EDS is in process.
37	SINGLE STEP	Causes the GSE automatic checkout equipment to step through its program 1 step at a time. (Indicator light above switch indicates that switch is ON.)
38	LIFTOFF RESET	Resets auto abort enable relays in the EDS Distributor. (Indicator light above switch indicates that these relays have been reset either by LIFTOFF RESET pushbutton or by IU Switch Selector.)
39	PITCH RATE EXCESSIVE 1, 2, and 3	Indicate that a pitch angular-overrate condition has been sensed by three pitch rate switches in the Control Signal Processor.
40	YAW RATE EXCESSIVE 1, 2, and 3	Indicate that a yaw angular-overrate condition has been sensed by three yaw rate switches in the Control Signal Processor.
41	ROLL RATE EXCESSIVE 1, 2, and 3	Indicate that a roll angular-overrate condition has been sensed by three roll rate switches in the Control Signal Processor.
42	ENG 1 through 5 THRUST OK 1, 2, and 3	Indicate that the three thrust OK switches for the respective S-IC engines are closed.

Legend for Figure 4-1 (Cont)

Index Number	Control or Indicator	Function
43	Function	Selects mode of operation for checkout of the EDS: OFF - Prevents power from being applied to EDS circuits in the IU. MONITOR - Allows power to be applied to EDS circuits while panel monitors conditions of circuits. TEST - Permits testing of EDS circuits by GSE automatic checkout equipment. LAUNCH - Enables the EDS ready circuits for actual or simulated flight.
44	LET JETTISON LOGIC ZERO	Indicates the LET jettison logic circuit is safe.
45	SEPARATION LOGIC ZERO	Indicates the separation logic circuit is safe.
46	SEQUENCE LOGIC ZERO	Indicates that neither the S-II/S-IVB separation sequence nor the Saturn/Apollo separation sequence has been initiated by the IU Switch Selector.

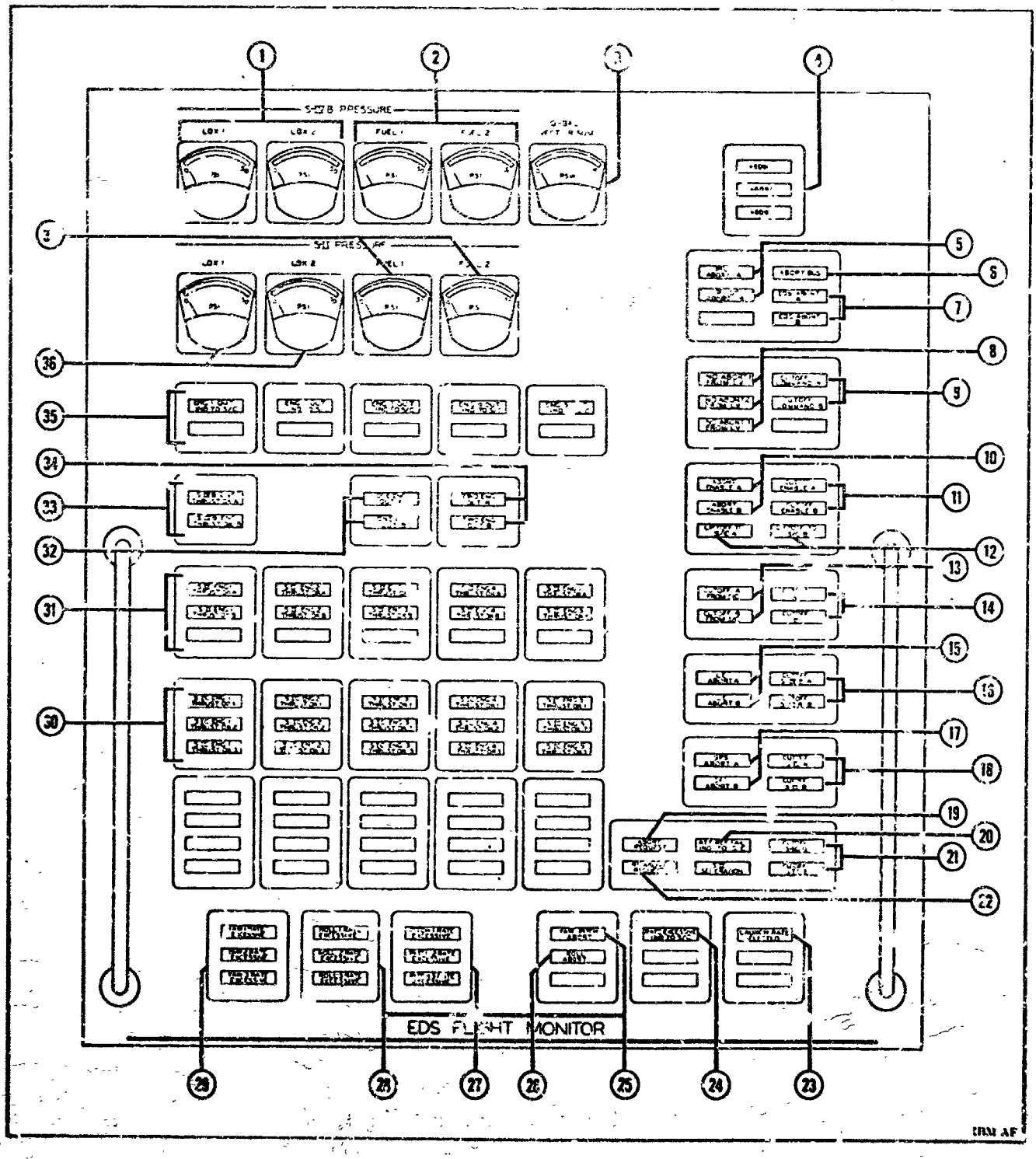


Figure 4-2. EDS Flight Monitor Panel

SECTION IV
GROUND SUPPORT EQUIPMENT

The Ground Support Equipment (GSE) for the EDS consists of four test and display panels, along with the automatic checkout equipment used for pre-launch checkout of all Saturn vehicle systems. The on-board EDS is checked by first simulating various emergency conditions in the vehicle, and then monitoring the resulting operation of the EDS circuits. Monitoring and some control of the pre-launch checkout is provided by the 4 EDS panels. Some of the panels also monitor the EDS circuits during vehicle flight. For more information on the interconnections between the on-board EDS and the GSE, refer to the Interface Control Document entitled, "Saturn-Apollo Emergency Detection System Checkout Schematics" (for the applicable vehicle).

Only the four EDS test and display panels will be described in this section. These panels are rack mounted and are located in the Launch Control Center at Kennedy Space Center.

4-1 EDS PREPARATION PANEL

Control and monitoring of EDS automatic checkout is provided by the EDS Preparation Panel. This panel can be used only during pre-launch checkout of the vehicle; the panel becomes inoperative after vehicle launch. Figure 4-1 shows the panel, and the accompanying legend describes each control and indicator. Refer to Section II of this manual for more information about the on-board EDS components mentioned in the figure legend.

4-2 EDS FLIGHT MONITOR PANEL

Containing indicator lights and meters, the EDS Flight Monitor Panel permits continuous monitoring of all important EDS functions during vehicle flight. The panel is active both prior to and during flight. All inputs to the panel are received through telemetry. The panel is shown in Figure 4-2, with the indicators described in the accompanying legend. Refer to Section II of this manual for more information about the on-board EDS components mentioned in the legend.

4-3 EDS/CONTROL RATE GYRO PANEL

The EDS/Control Rate Gyro Panel provides control and monitoring of the IU Control-EDS Rate Gyro Package and its Control Signal Processor. Control functions and some of the monitoring functions at the panel are available only during pre-launch checkout. Inputs for other monitoring functions are obtained through telemetry and are therefore available during vehicle flight as well as pre-launch checkout.

The EDS/Control Rate Gyro Panel is shown in Figure 4-3. Descriptions of the controls and indicators are given in the legend accompanying the figure. When a panel switch having an AUTO position is set to that position, the associated function can be controlled by the GSE checkout computer.

4-4 Q-ANGLE OF ATTACK PANEL

Control and monitoring of the Q-Ball is the prime function of the Q-Angle of Attack Panel. Control is permitted only during pre-launch checkout, but monitoring is available during both pre-launch checkout and vehicle flight. Monitoring of Q-Ball cover removal is also provided by the panel. The panel is shown in Figure 4-4, with the controls and indicators described in the legend. When a panel switch having an AUTO position is set to that position, the associated function can be controlled by the GSE checkout computer.

Legend for Figure 4-2

Index Number	Control or Indicator	Function
1	S-IVB PRESSURE LOX 1 and 2	Display the pressure in the S-IVB oxygen tank (duplex circuits).
2	S-IVB PRESSURE FUEL 1 and 2	Display the pressure in the S-IVB fuel tank (duplex circuits).
3	Q-BALL VECTOR SUM	(Not used)
4	6D91, 6D92, and 6D93	Indicate that the respective buses are energized.
5	PILOT ABORT A and B	Indicate that a manual abort has been initiated by the pilot (duplex circuits).
6	ABORT BUS	Indicates that the auto abort bus in the EDS Distributor has been energized.
7	EDS ABORT A and B	Indicate that an automatic abort has been initiated by the EDS (duplex circuits).
8	NO ABORT FROM L/V 1, 2, and 3	Indicate that no automatic abort initiate signals are sent to the Spacecraft from EDS Distributor.
9	CUTOFF COMMAND A and B	Indicate that at least two of the three engine cutoff signals from the MESC's have been received by the EDS Distributor (duplex circuits).
10	ABORT ENABLED A and B	Indicate that an automatic abort has been enabled in the Command Module (duplex circuits).
11	CUTOFF ENABLED A and B	Indicate that engine cutoff has been enabled by the IU Switch Selector and by the EDS Cutoff Inhibit Timer, respectively.
12	LIFTOFF TO S/C A and B	Indicates that a liftoff signal has been sent from the EDS Distributor to the Command Module.
13	CUTOFF FROM S/C A and B	Indicate that engine cutoff signals have been produced in the MESC's (duplex circuits).
14	CUTOFF A and B	Indicate that engine cutoff signals have been sent to the operating stage from the IU (duplex circuits).
15	LES ABORT A and B	Indicate that the LES abort mode has been initiated in the Spacecraft (duplex circuits).
16	CUTOFF S-IVB A and B	Indicate cutoff of S-IVB engine.

Legend for Figure 4-2 (Cont)

Index Number	Control or Indicator	Function
17	SPS ABORT A and B	Indicate that the SPS abort mode has been initiated in the Spacecraft (duplex circuits).
18	CUTOFF S-II A and B	Indicate cutoff of S-II engines.
19	ABORT REQUEST	Indicates that an abort request signal has been received by the Command Module.
20	ATT REF FAIL IND TO S/C	Indicates that an attitude reference failure signal has been sent from the EDS Distributor to the Command Module for display
21	CUTOFF S-IC A and B	Indicates cutoff of S-IC engines (duplex circuits).
22	RF ABORT REQUEST	Indicates that an abort request has been transmitted to the Spacecraft from the ground.
23	LAUNCH RATE SELECTED	Indicates that a new angular-overrate has been selected in the IU.
24	RATE EXCESSIVE IND TO S/C	Indicates that an angular-overrate signal has been sent from the EDS Distributor to the Command Module for display.
25	YAW-PITCH ABORT	Indicates that a yaw or pitch angular-overrate signal has been produced in the IU.
26	ROLL ABORT	Indicates that a roll angular-overrate signal has been produced in the IU.
27	PITCH RATE EXCESSIVE 1, 2 and 3	Indicate that a pitch angular-overrate has been sensed by three pitch rate switches in the Control Signal Processor.
28	ROLL RATE EXCESSIVE 1, 2, and 3	Indicate that a roll angular-overrate has been sensed by three roll rate switches in the Control Signal Processor.
29	YAW RATE EXCESSIVE 1, 2, and 3	Indicate that a yaw angular-overrate has been sensed by three yaw rate switches in the Control Signal Processor.
30	S-IC ENG THRUST OK 1, 2, 3, 4, and 5	Indicates that the three thrust OK switches for the respective S-IC engines are closed.
31	S-II ENG THRUST OK 1, 2, 3, 4, and 5	Indicates that the three thrust OK switches for the respective S-II engines are closed.

Legend for Figure 4-2 (Cont)

Index Number	Control or Indicator	Function
32	ONE ENG OUT A and B	Indicates that one S-IC engine is out.
33	S-IVB ENG THRUST OK A and B	Indicate that both thrust OK switches for the S-IVB engine are closed.
34	TWO ENG OUT A and B	Indicate that at least two S-IC engines are out (duplex circuits).
35	ENG OUT IND TO S/C 1, 2, 3, 4, and 5	Indicate that the respective engine-out signals have been sent from the EDS Distributor to the Command Module for display.
36	S-II PRESSURE LOX 1 and 2	Display the pressure in the S-II oxygen tank (duplex circuits).
37	S-II PRESSURE FUEL 1 and 2	Display the pressure in the S-II fuel tank (duplex circuits).

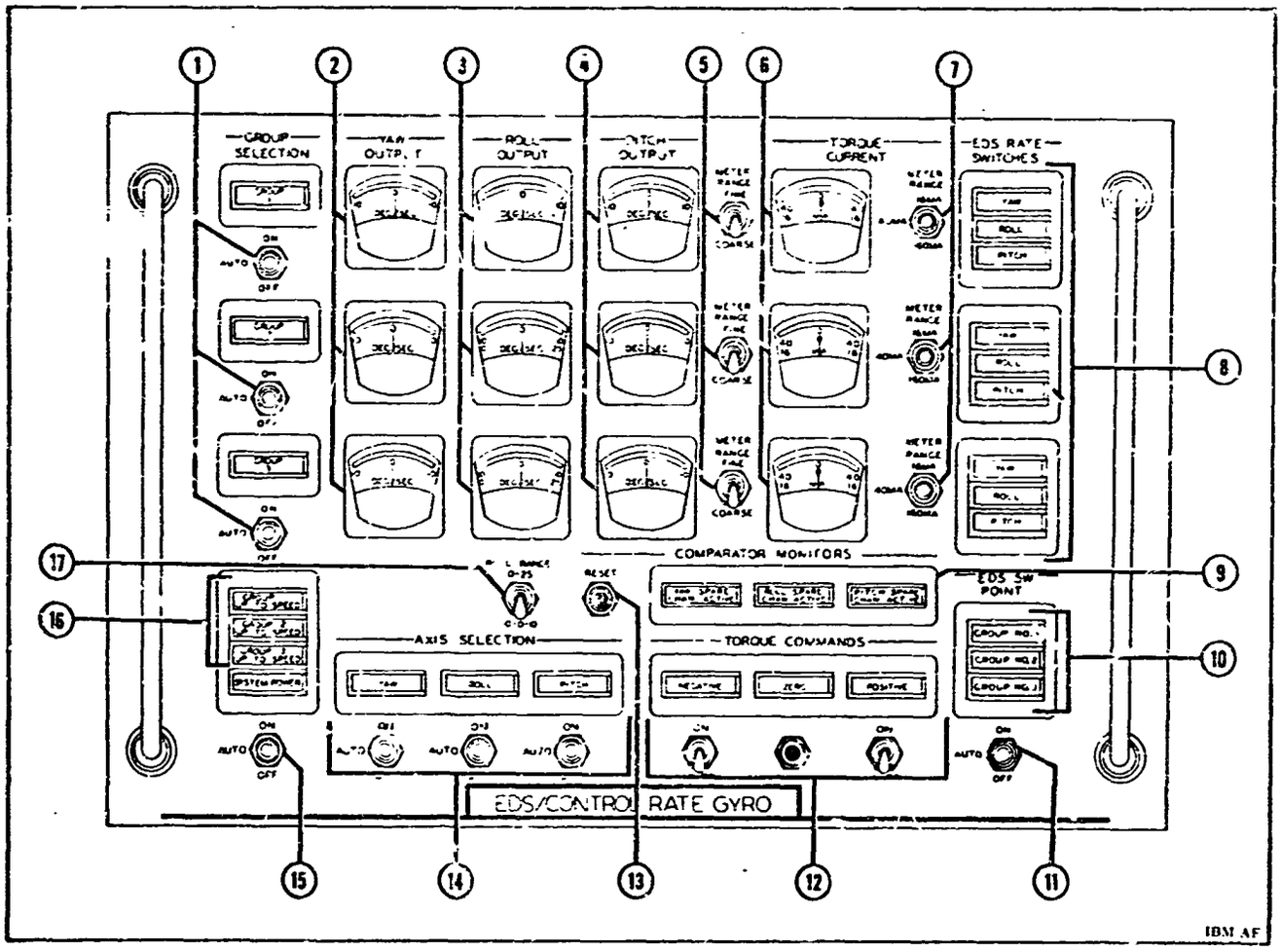


Figure 4-3 EDS/Control Rate Gyro Panel

Legend for Figure 4-3

Index Number	Control or Indicator	Function
1	GROUP SELECTION 1, 2, and 3	Select the associated group of rate gyros for testing. (Indicator light above each switch indicates that the respective group has been selected.)
2	YAW OUTPUT	Display the yaw rate outputs of the Control Signal Processor. The meters are calibrated in degrees per second.
3	ROLL OUTPUT	Display the roll rate outputs of the Control Signal Processor. The meters are calibrated in degrees per second.
4	PITCH OUTPUT	Display the pitch rate outputs of the Control Signal Processor. The meters are calibrated in degrees per second.

Legend for Figure 4-3 (Cont)

Index Number	Control or Indicator	Function
5	METER RANGE	Control the range of the associated group of output meters. The coarse range is 0 ± 10 degrees per second and the fine range is 0 ± 1 degree per second.
6	TORQUE CURRENT	Display the output current of the torquing amplifier associated with each group of rate gyros.
7	METER RANGE	Control the range of the associated TORQUE CURRENT meters.
8	EDS RATE SWITCHES	Indicate that an angular-overrate has been sensed by the associated rate switches in the Control Signal Processor.
9	COMPARATOR MONITORS – SPARE CHANNEL ACTIVE YAW, ROLL, and PITCH	Indicate that the associated spare channel in the Control Signal Processor has been activated.
10	EDS SW POINT	Provides an indication of a change in the angular-overrate limits within the Control Signal Processor.
11	EDS SW POINT CONTROL	Controls change in angular-overrate limits within the Control Signal Processor.
12	TORQUE COMMANDS – POSITIVE, ZERO, and NEGATIVE	Control the output of the selected rate gyro torquing amplifier. Output of the selected amplifier torques a selected rate gyro, which, in turn, produces an angular rate signal. This signal is conditioned in the Control Signal Processor and eventually displayed on the output meters on the panel. (Indicator light above each switch indicates that the respective torque command has been issued.)
13	COMPARATOR MONITOR – RESET	Restores the command channel in the Control Signal Processor to an active status and returns the spare to standby.
14	AXIS SELECTION – YAW, ROLL, and PITCH	Select the rate gyro to be tested within the group selected by the GROUP SELECTION switches (index number 1). (Indicator light above each switch indicates that the respective axis has been selected.)
15	SYSTEM POWER	Controls the power for operating and testing the Control-EDS Rate Gyro Package and the Control Signal Processor. (Indicator light immediately above switch indicates that the power has been applied.)

Legend for Figure 4-3 (Cont)

Index Number	Control or Indicator	Function
16	UP TO SPEED – GROUP 1, 2, and 3	Indicate that the rate gyros have reached operating speed.
17	ROLL RANGE	Changes the range of the ROLL OUTPUT meters from that selected by the METER RANGE switch (index number 5) to a range of 0-25 degrees per second.

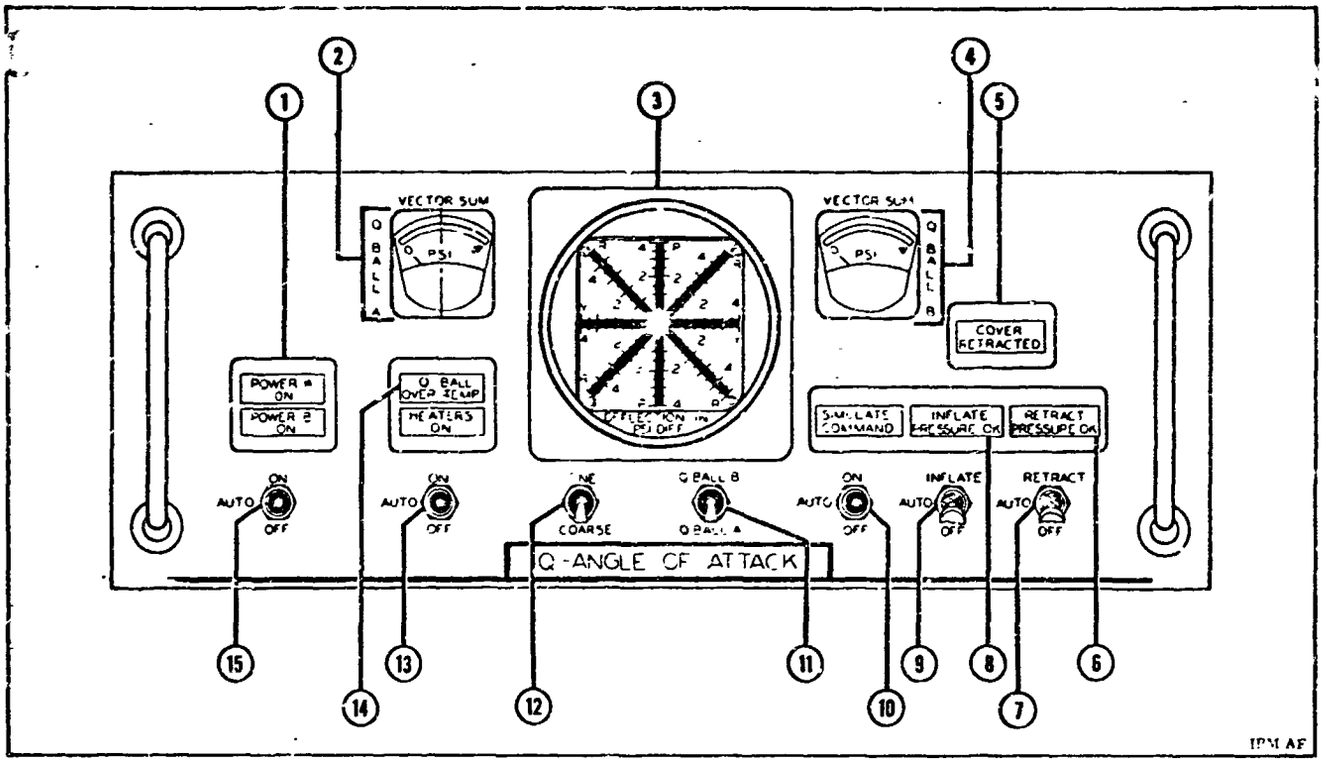


Figure 4-4 Q-Angle of Attack Panel

Legend for Figure 4-4

Index Number	Control or Indicator	Function
1	POWER A and B	Indicate that dc power has been applied to the Q-Ball from the IU (duplex circuits).
2	VECTOR SUM A	(Not used)
3	Pitch and Yaw Indicator	Displays (on 1 indicator) separate pitch and yaw differential pressures detected by the Q-Ball.
4	VECTOR SUM B	Displays the vector sum of the pitch and yaw differential pressures detected by the Q-Ball.
5	COVER RETRACTED	Indicates that the Q-Ball cover has been removed.
6	RETRACT PRESSURE OK	Indicates that the GN_2 pressure is correct for retracting the Q-Ball cover.
7	RETRACT	(Not used)
8	INFLATE PRESSURE OK	Indicates that the GN_2 pressure is correct for inflating the bladder of the Q-Ball cover.

Legend for Figure 4-4 (Cont)

Index Number	Control or Indicator	Function
9	INFLATE	(Not used)
10	SIMULATE COMMAND	Controls application of signals within the Q-Ball to simulate the inputs from the pitch and yaw pressure transducers. (Indicator light above switch indicates that a simulate command has been issued.)
11	Q-BALL FUNCTION A and B	(Not used)
12	FINE-COARSE	Controls the range of the Pitch and Yaw Indicator and the two vector sum meters.
13	Heaters	Controls the ac power applied to the heater element in the Q-Ball. (Indicator light above switch indicates that power has been applied.)
14	Q-BALL OVER TEMP	(Not used)
15	Power	Controls the dc power applied to Q-Ball circuits from the IU.

SECTION V
APOLLO-SATURN EDS VEHICLE DATA SHEETS

The Data Sheets included herein provide current updated EDS changes affecting the Apollo-Saturn 500 Series Vehicles. Each Data Sheet provides both circuitry changes and text description changes applicable to the vehicle specified on the tab. The information for each vehicle is self supporting, and reference to prior Data Sheets is not required unless so specified.

NOTICE

A thorough knowledge of the EDS operational concepts discussed within Sections I through IV is essential to the complete understanding of the information contained in the Data Sheets.

THE CONTENTS OF THE PRECEDING SECTIONS OF THIS MANUAL APPLY TO THE VEHICLE SPECIFIED ON THESE DATA SHEETS EXCEPT FOR THE FOLLOWING DIFFERENCES:

H Figure 2-6, Abort Sequence Functional Schematic (Sheet 1), and accompanying text have been changed as shown on Figure 501-1.

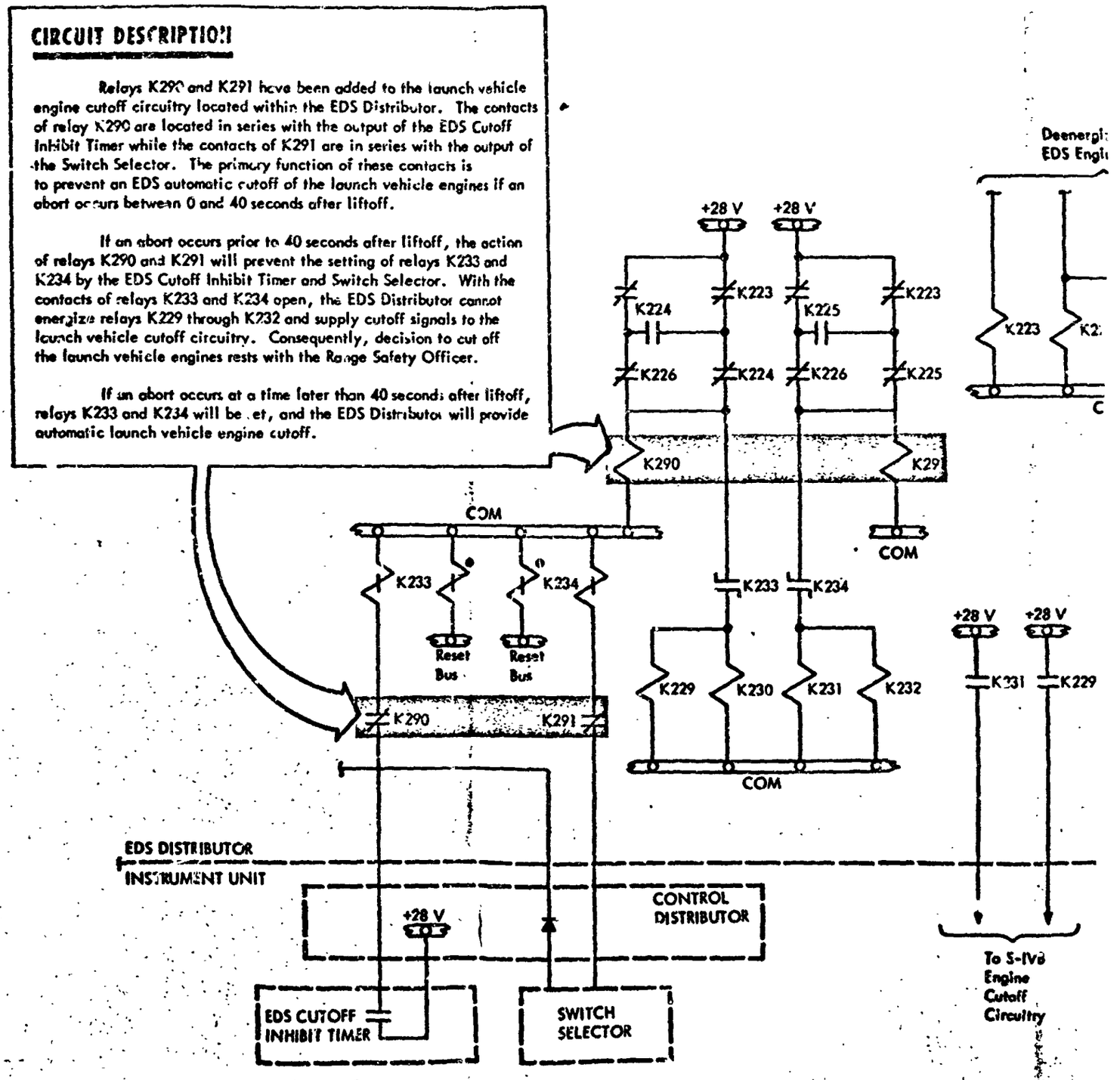
In the event an abort occurs prior to 30-seconds after vehicle liftoff, launch vehicle operating engine cutoff must be activated by the Range Safety Officer.

CIRCUIT DESCRIPTION

Relays K290 and K291 have been added to the launch vehicle engine cutoff circuitry located within the EDS Distributor. The contacts of relay K290 are located in series with the output of the EDS Cutoff Inhibit Timer while the contacts of K291 are in series with the output of the Switch Selector. The primary function of these contacts is to prevent an EDS automatic cutoff of the launch vehicle engines if an abort occurs between 0 and 40 seconds after liftoff.

If an abort occurs prior to 40 seconds after liftoff, the action of relays K290 and K291 will prevent the setting of relays K233 and K234 by the EDS Cutoff Inhibit Timer and Switch Selector. With the contacts of relays K233 and K234 open, the EDS Distributor cannot energize relays K229 through K232 and supply cutoff signals to the launch vehicle cutoff circuitry. Consequently, decision to cut off the launch vehicle engines rests with the Range Safety Officer.

If an abort occurs at a time later than 40 seconds after liftoff, relays K233 and K234 will be set, and the EDS Distributor will provide automatic launch vehicle engine cutoff.



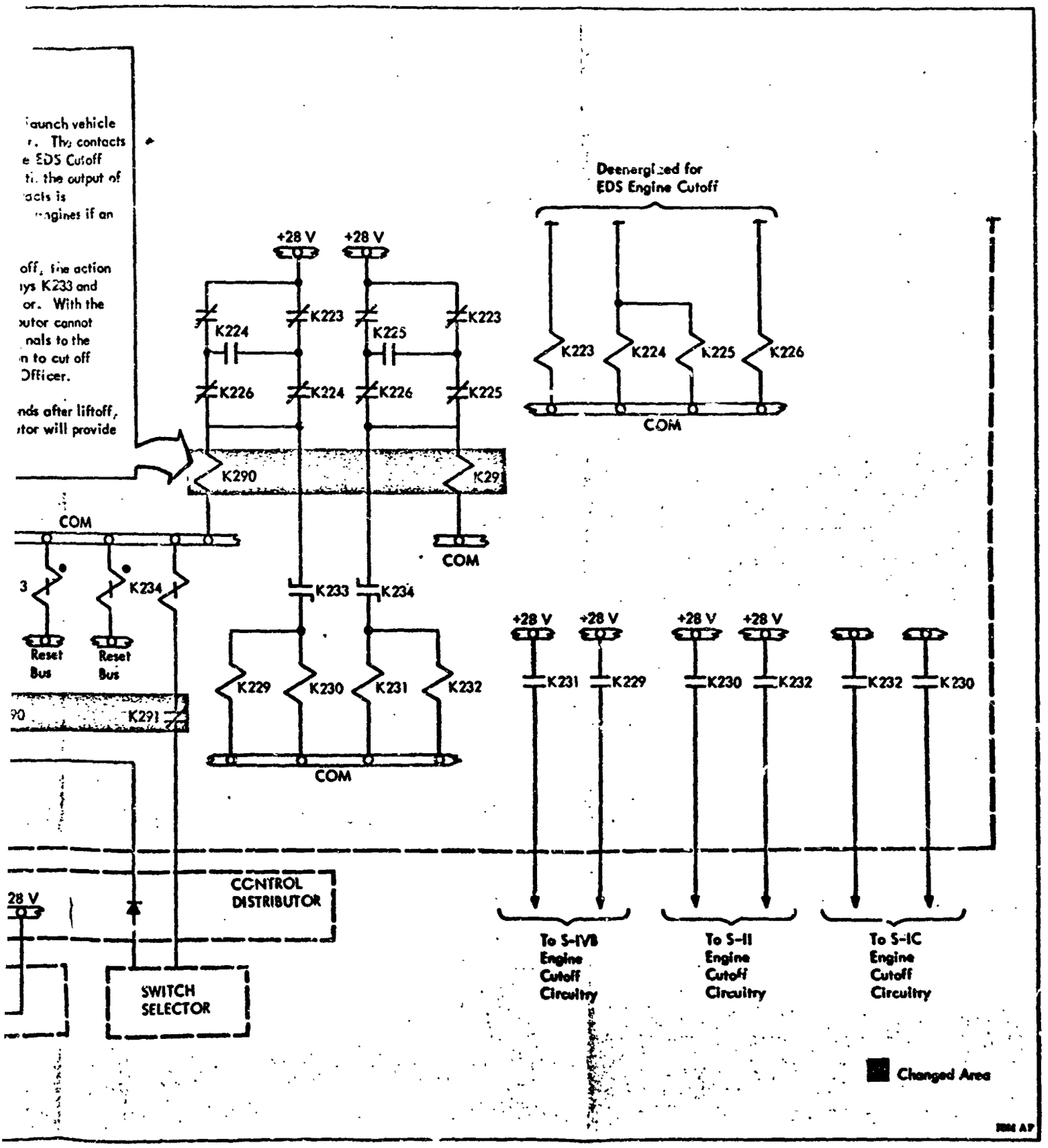
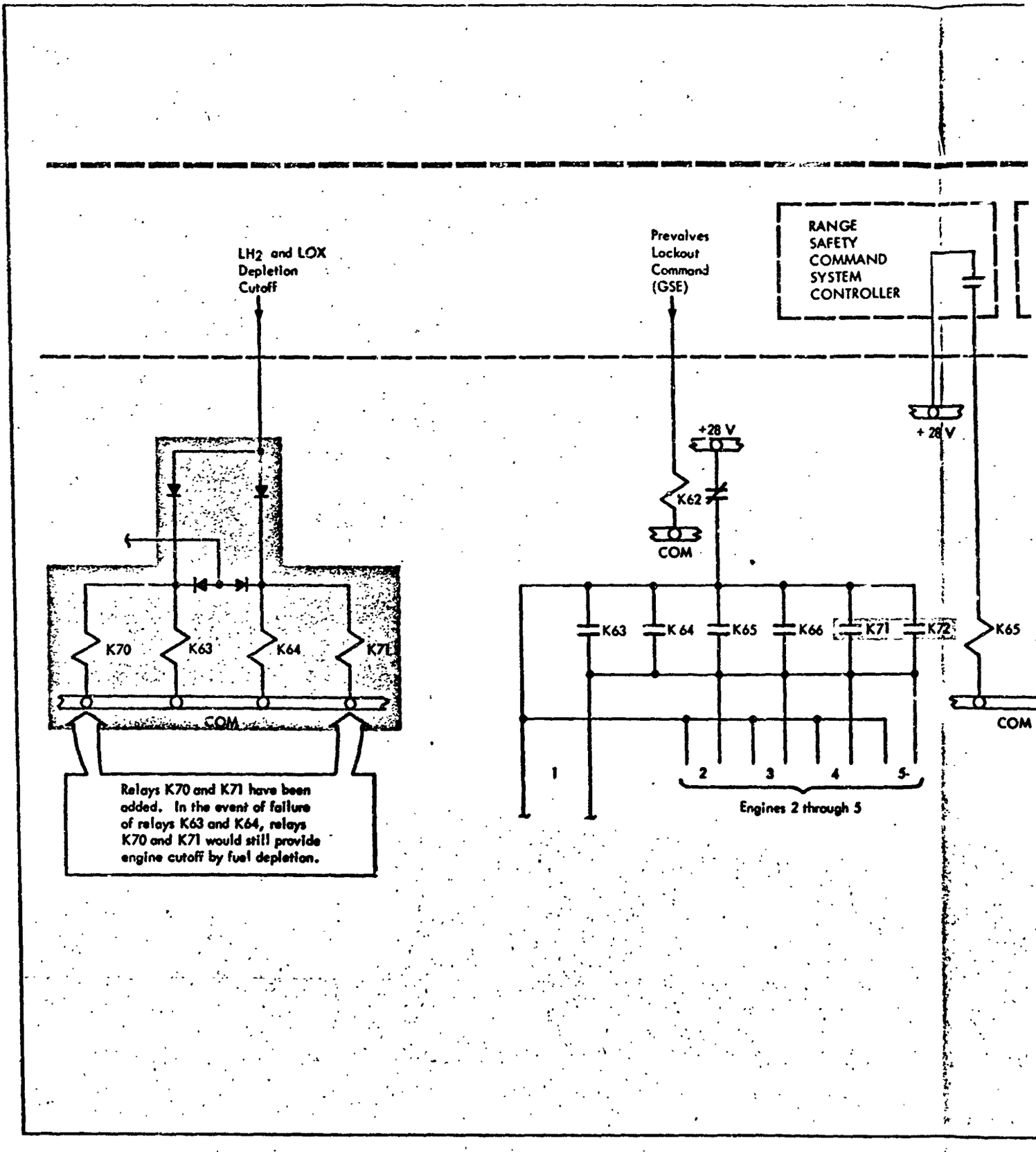


Figure 501-1
Abort Sequence Functional Schematic Modification Drawing
S-4A/S-4B

THE CONTENTS OF THE PRECEDING SECTIONS OF THIS MANUAL APPLY TO THE VEHICLE SPECIFIED ON THESE DATA SHEETS EXCEPT FOR THE FOLLOWING DIFFERENCES:

(1) Figure 2-8, S-II Engine-Cutoff Functional Schematic has been changed as shown on Figure 502-1.

Redundant engine cutoff capability has been provided for the EDS engine cutoff circuitry and the LOX and LH_2 fuel depletion engine cutoff circuitry.


LH2 and LOX
Depletion
Cutoff
Prevalves
Lockout
Command
(GSE)
RANGE
SAFETY
COMMAND
SYSTEM
CONTROLLER
+28 V
+28 V
K62
COM
K70
K63
K64
K71
COM
K63
K64
K65
K66
K71
K72
K65
COM
1
2
3
4
5
Engines 2 through 5
Relays K70 and K71 have been added. In the event of failure of relays K63 and K64, relays K70 and K71 would still provide engine cutoff by fuel depletion.

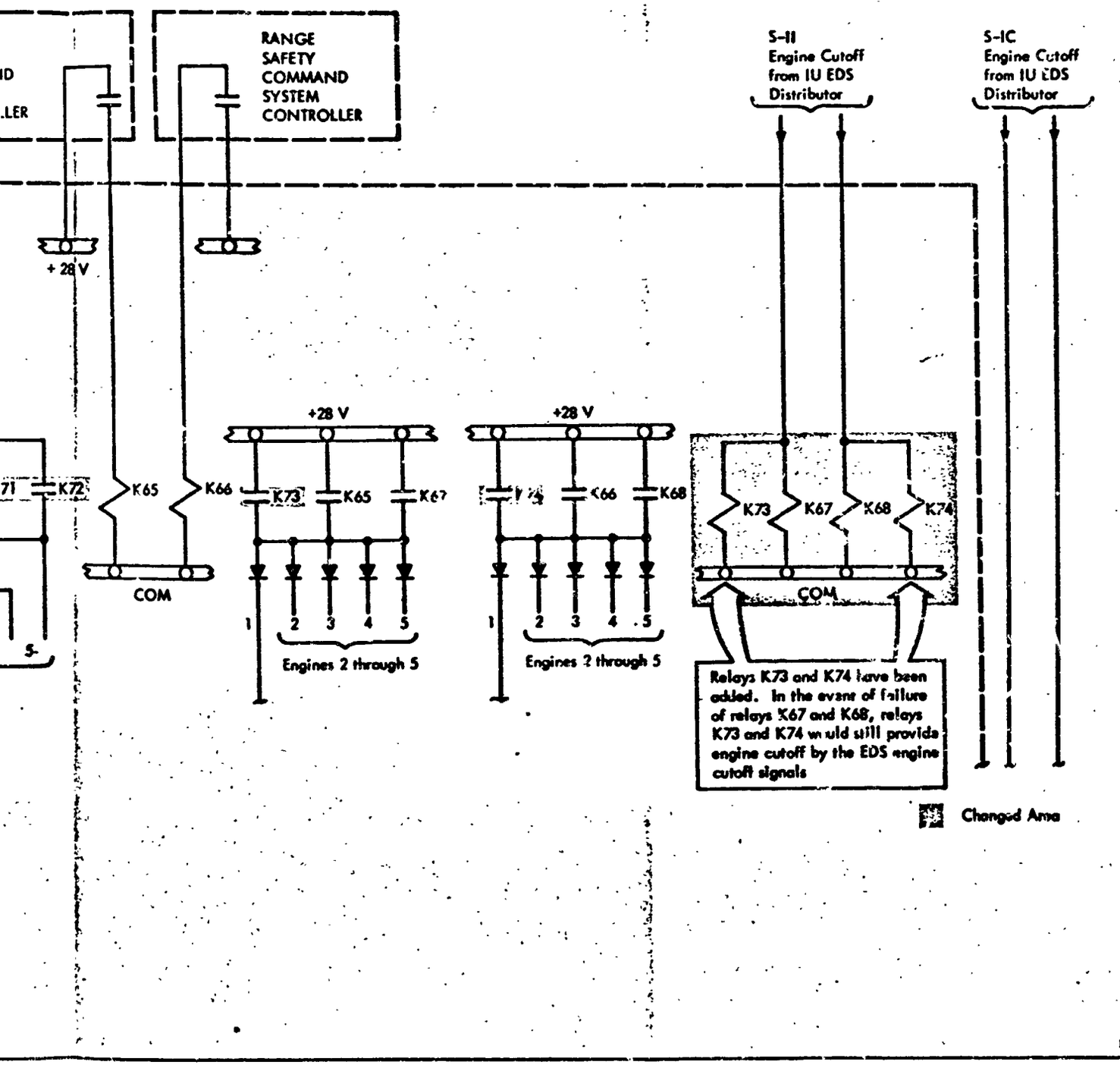


Figure 502-1
S-II Engine-Cutoff Functional Schematic Modification Drawing

THE CONTENTS OF THE PRECEDING SECTIONS OF THIS MANUAL APPLY TO THE VEHICLE SPECIFIED ON THESE DATA SHEETS EXCEPT FOR THE FOLLOWING DIFFERENCES:

(1) Relays K240, K241, and K242 have been added to the EDS Distributor to supply +28 Vdc to the LV RATE EXCESSIVE lamps within the Spacecraft when an angular overrate condition exists. Therefore, the Angular Overrate Manual-Abort Schematic, Figure 2-3, and accompanying text have been changed as shown on Figure 5-1.

(2) Figure 2-7, S-IVB Engine-Cutoff Functional Schematic, and accompanying text have been changed as shown on Figure 5-2. Since the majority of the circuitry has been changed, Figure 5-2 is inserted as a new figure with no change areas indicated.

(3) A manual abort indication is changed as follows:

From • S-II and S-IVB fuel tank pressures (4 meters).

To • S-II and S-IVB fuel tank pressures (4 meters - Upon S-II/S-IVB separation, two of the four fuel tank indicators are used to indicate S-IVB LOX tank pressure).

(4) Vehicle AS-503 uses a Block II Spacecraft Control Panel, and Figures 1-2 through 1-5 are replaced by Figures 5-3, 5-4, and 5-5.

(5) Figure 2-6, Abort Sequence Functional Schematic (Sheet 2) is changed as shown on Figure 5-6. No text change is required. The changed area is depicted by shading.

(6) The EDS Cutoff Inhibit Timer listed in Table 1-1 has been changed to a 30-second timer.

(7) Figure 2-4, Engine Out Manual-Abort Indication Functional Schematic (Typical), has been changed as shown on Figure 5-7.

A redundant signal line has been inserted in the S-II and S-IVB engine thrust monitoring circuitry.

AS-503
Data Sheets

THE CONTENTS OF THE PRECEDING SECTIONS OF THIS MANUAL APPLY TO THE VEHICLE SPECIFIED ON THESE DATA SHEETS EXCEPT FOR THE FOLLOWING DIFFERENCES:

1. Relays K240, K241, and K242 have been added to the EDS Distributor to supply +28 V to the LV RATE EXCESSIVE lamps within the Spacecraft when an angular overrate condition exists. Therefore, the Angular Overrate Manual-Abort Schematic, Figure 2-3 and accompanying text have been changed as shown on Figure 5-1.

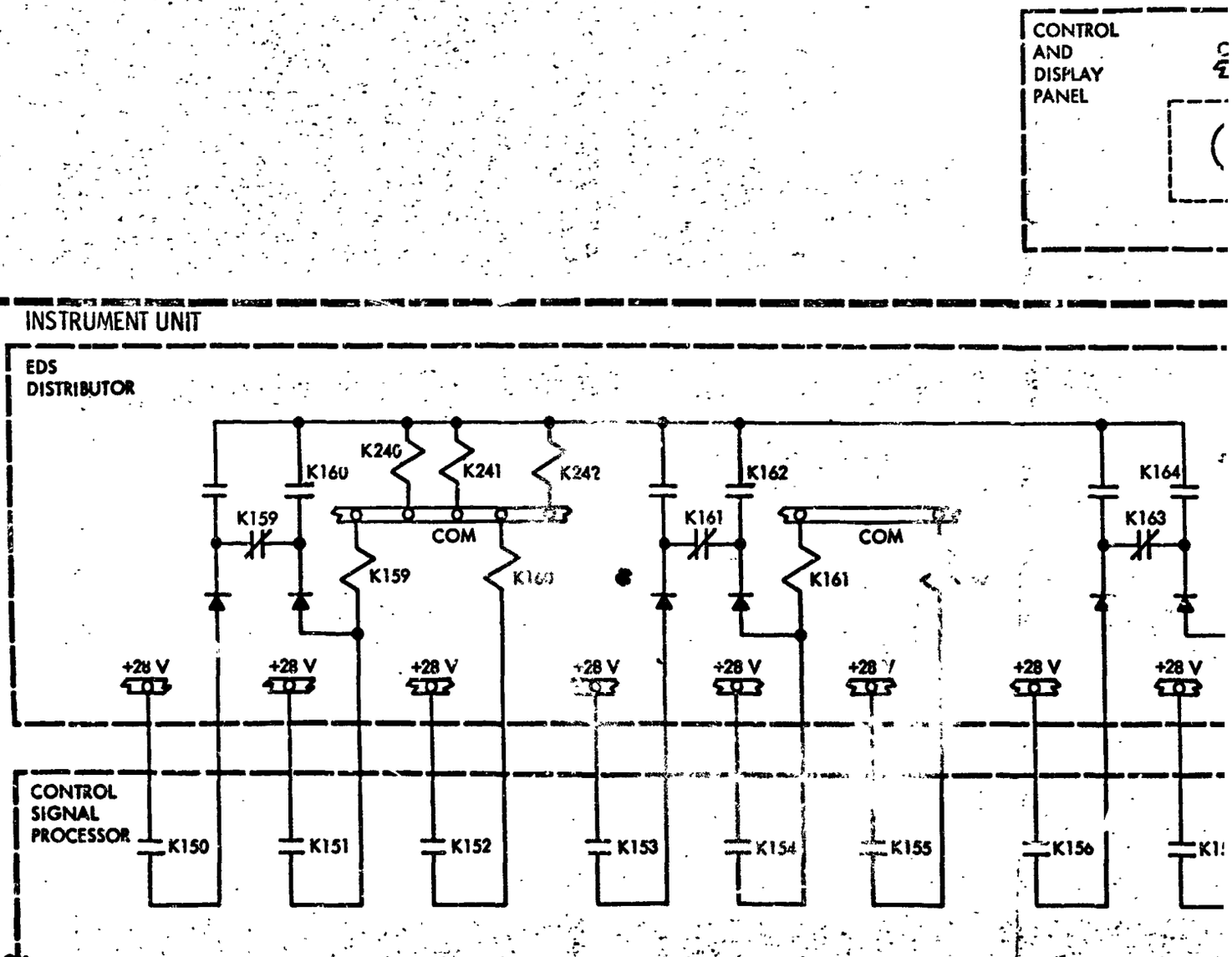
2. Figure 2-7, S-IVB Engine - Cutoff Functional Schematic and accompanying text have been changed as shown on Figure 5-2. Since the majority of the circuitry has been changed, Figure 5-2 is inserted as a new figure with no change areas indicated.

3. A manual abort indication is changed as follows:

From	• S-II and S-IVB fuel tank pressures (4 meters).
To	• S-II and S-IVB fuel tank pressures (4 meters - Upon S-II/S-IVB separation, two of the four fuel tank indicators are used to indicate S-IVB LOX tank pressure).

4. Vehicle AS-503 uses a Block II Spacecraft Control Panel, and Figures 1-2 through 1-5 are replaced by Figures 5-3, 5-4, and 5-5.

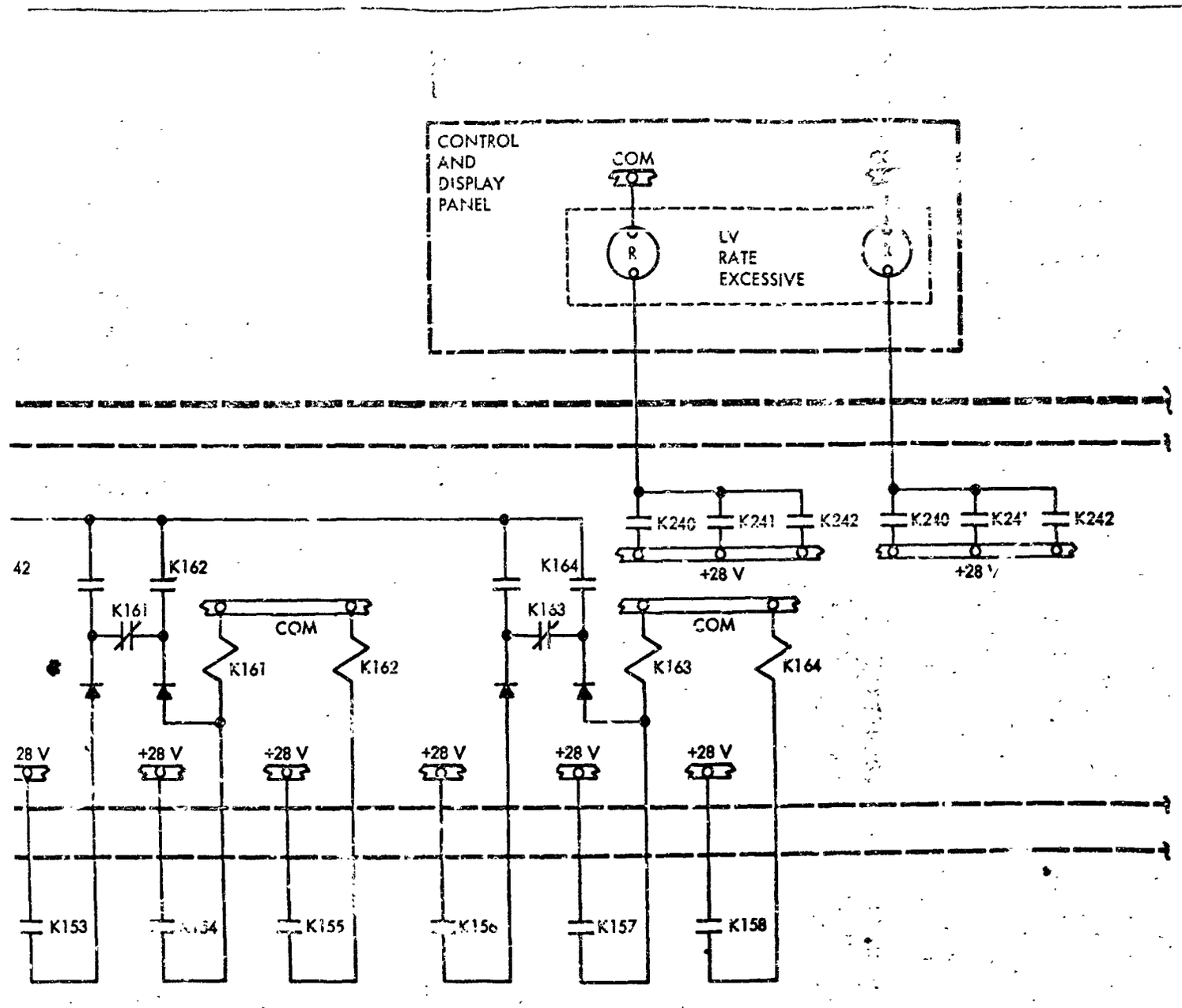
5. Figure 2-6, Abort Sequence Functional Schematic (Sheet 2 of 2) is changed as shown on Figure 5-6. No text change is required. The changed area is depicted by shading.



CIRCUIT DESCRIPTION

Since the roll, pitch, and yaw overrate circuits are identical, only the roll circuit will be discussed. When any two of the three roll rate switches sense an angular overrate, their associated relays K150 through K152 in the Control Signal Processor are energized and +28V is supplied to relays K159 or K160, or both, in the EDS Distributor (Refer to paragraph 2-5 for a description of this sequence.).

Therefore, with either K159 or K160 energized, +28V will be supplied through the normally open contacts of K159 or K160 or both, and will energize relay K240. Then +28V is supplied through the normally open contacts of relay K240 to the LV RATE EXCESSIVE lamps within the Control and Display Panel of the Spacecraft. The yaw and pitch circuitry operates in a similar manner to energize relays K240 and K241.



Therefore, with either K159 or K160 energized, +28V will be supplied through the normally open contacts of K159 or K160 or both, and will energize relay K240. Then +28V is supplied through the normally open contacts of relay K240 to the LV RATE EXCESSIVE lamps within the Control and Display Panel of the Spacecraft. The yaw and pitch circuitry operates in a similar manner to energize relays K240 and K241.

IBM AF

Figure 5-1

Angular Overrate Manual-Abort Indication Modification Drawing

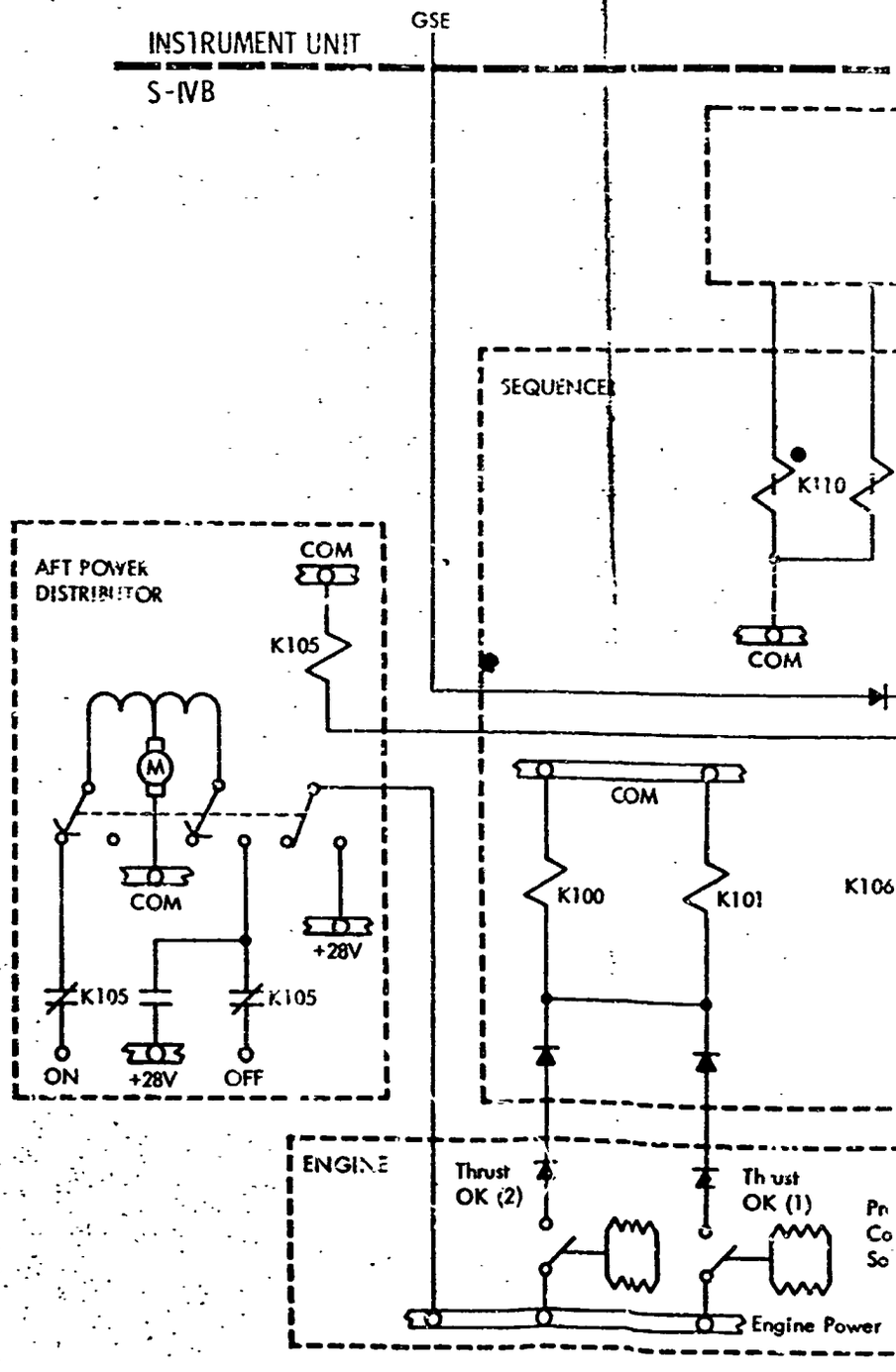
CIRCUIT DESCRIPTION

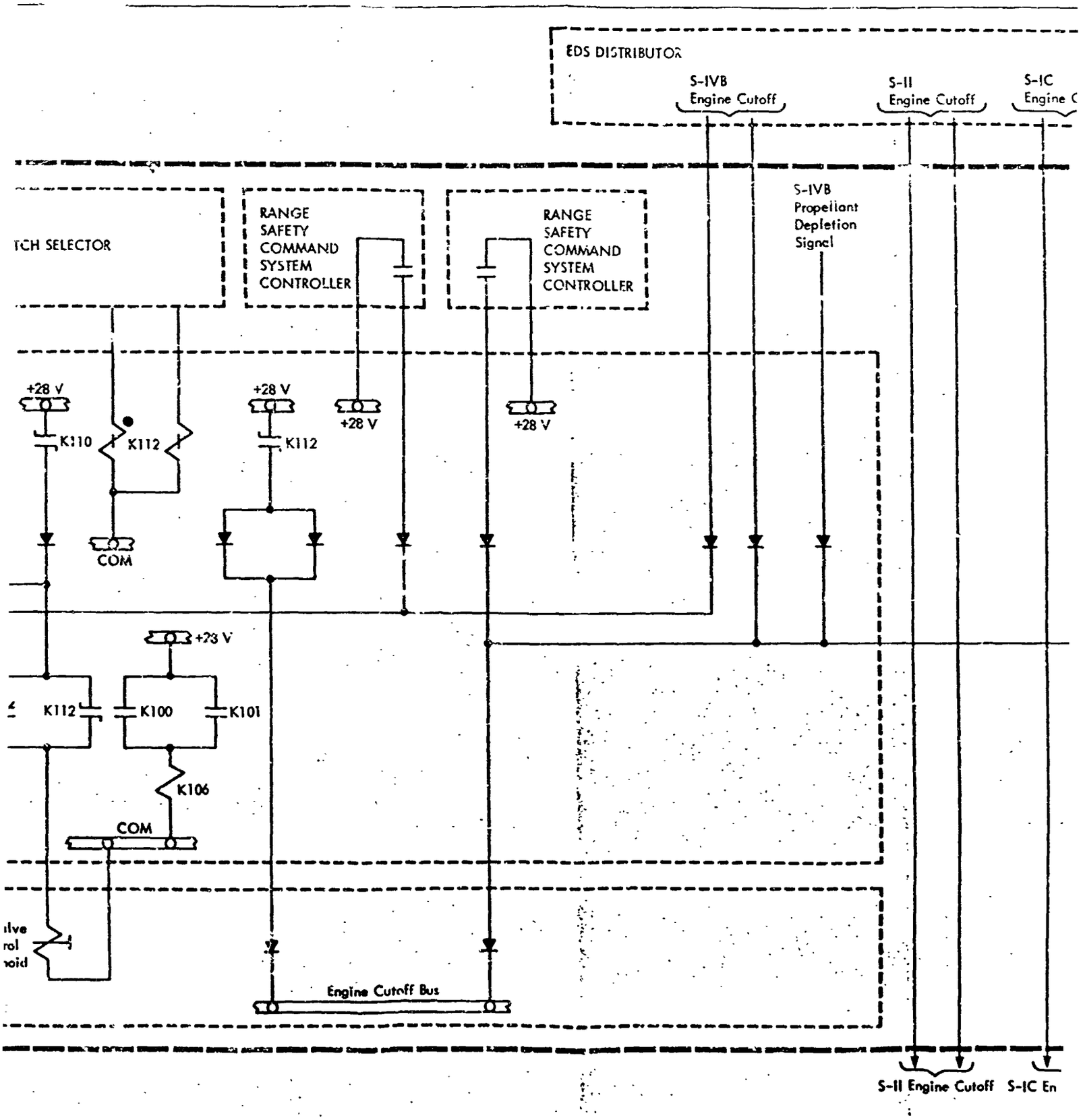
For cutoff of the S-IVB engine of Vehicle AS-503, the cutoff signals from the EDS Distributor are applied not only to the S-IVB cutoff bus, thereby cutting off the engine, but also to relay K105 in the Aft Power Distributor. Relay K105 is energized, and its normally open contacts in the Aft Power Distributor supply +28V to the OFF contact of the motor switch. When the motor switch is actuated, its switch arms are driven to the position shown, and +28V is removed from the engine power bus. With the removal of +28V, relays K100, K101, and subsequently, K106 in the Sequencer are deenergized. If the stage Switch Selector has set relay K110, then +28V is supplied to the prevalve control solenoid actuating the prevalve of the engine.

It should be noted that the engine thrust switches would normally open when the engine cutoff bus is energized and the resultant action would be as stated above.

The action of relay K106 assures that the prevalve control solenoid cannot be actuated prior to engine cutoff.

In addition to EDS cutoff, the engine can be cutoff by the stage Switch Selector, GSE, the Range Safety Control System, and by depletion of engine propellants. As shown the stage Switch Selector can control the engine cutoff bus directly but cannot control the prevalve solenoid without first energizing the engine cutoff bus.




EDS DISTRIBUTOR
S-IVB Engine Cutoff
S-II Engine Cutoff
S-IC Engine C
TCH SELECTOR
RANGE SAFETY COMMAND SYSTEM CONTROLLER
RANGE SAFETY COMMAND SYSTEM CONTROLLER
S-IVB Propellant Depletion Signal
+28 V
+28 V
+28 V
+28 V
K110
K112
K112
COM
+28 V
K112
K100
K101
K106
COM
Engine Cutoff Bus
S-II Engine Cutoff
S-IC En

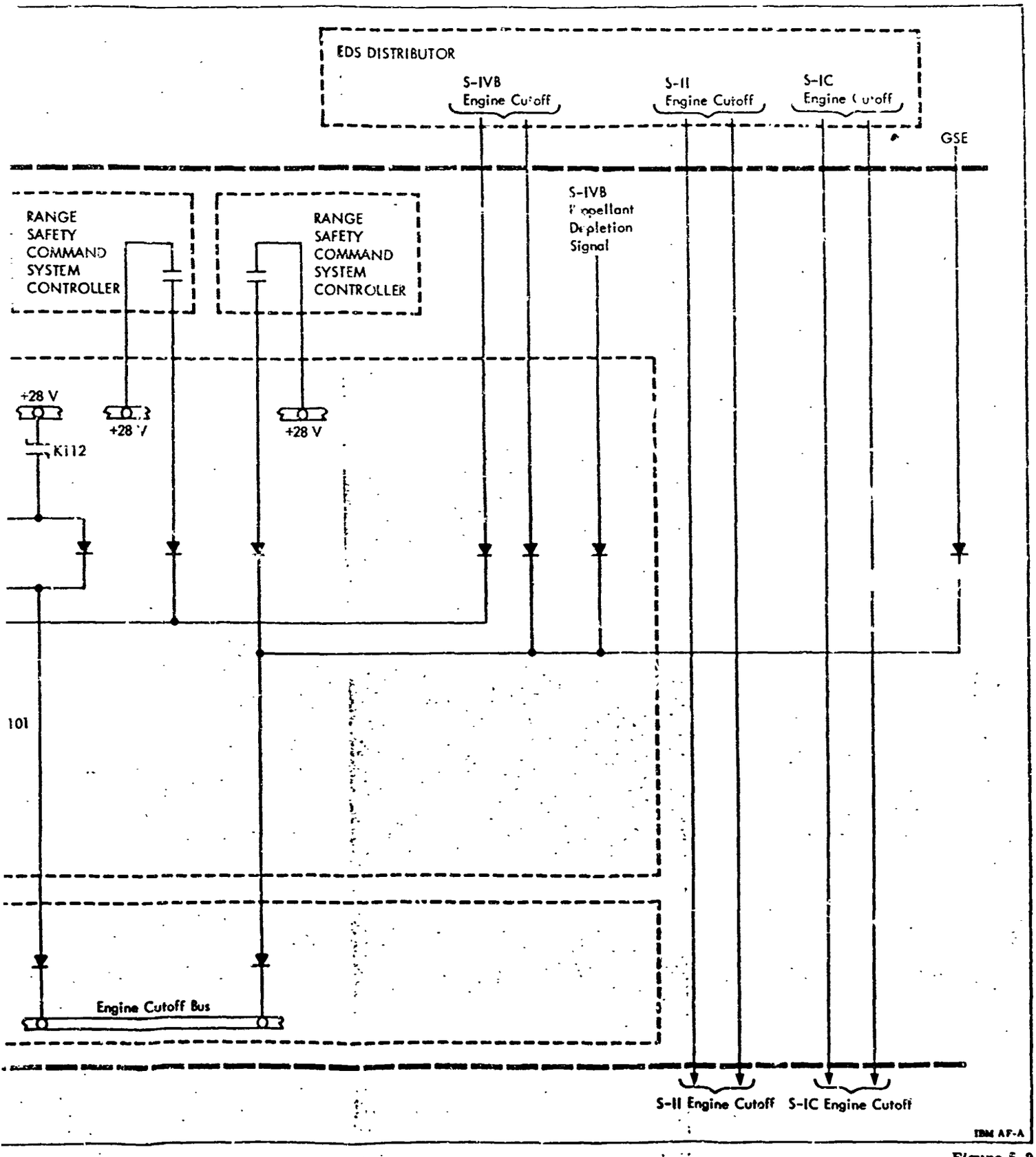


Figure 5-2
S-IVB Engine Cutoff Functional Schematic

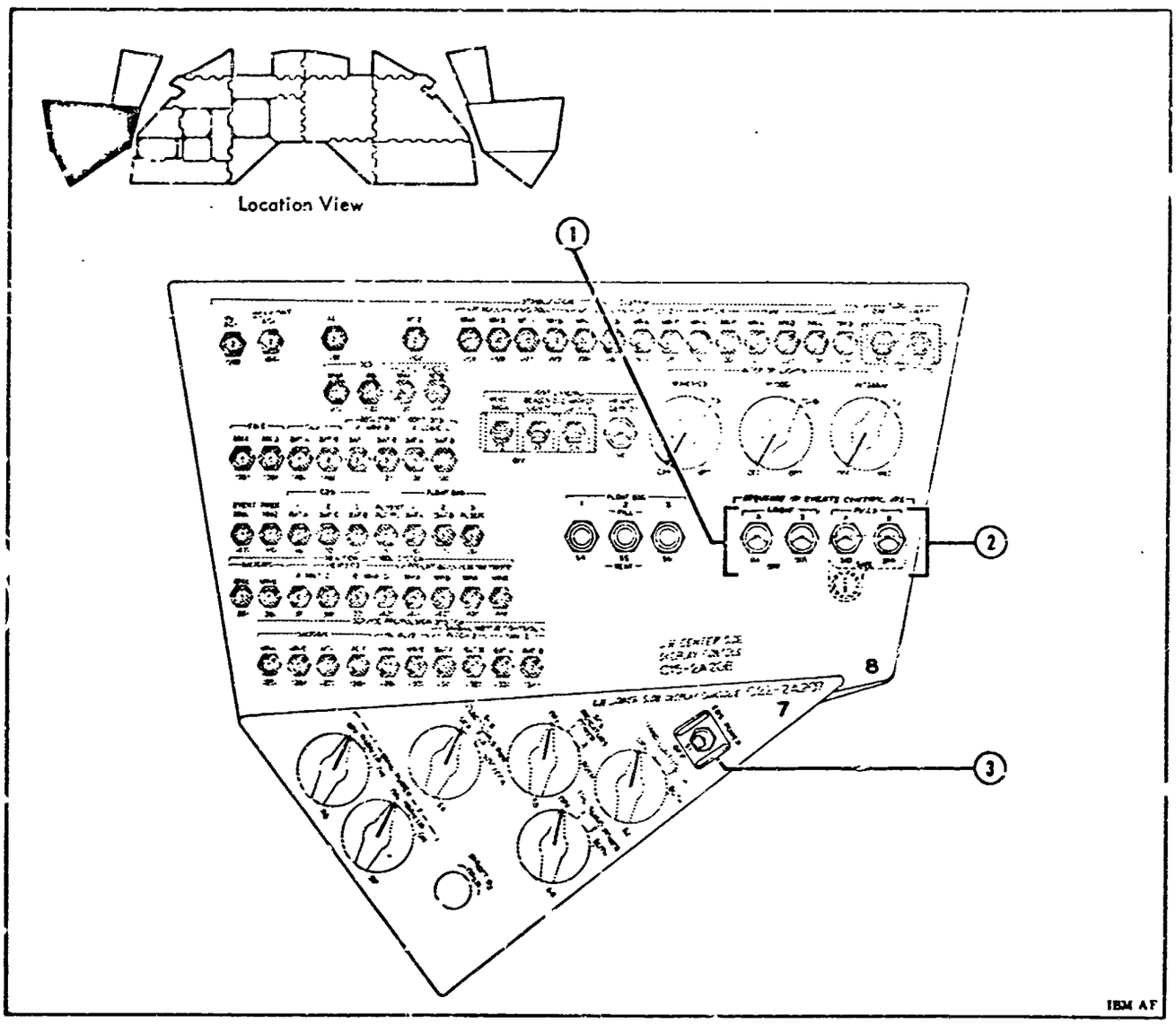


Figure 5-3. Mission Sequence Controls, Block II (Panels 7 & 8)

Legend for Figure 5-3

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	SEQUENCE OF EVENTS CONTROL SYS.	MASTER EVENTS SEQUENCE CONTROLLER LOGIC
2	SEQUENCE OF EVENTS CONTROL SYS.	MASTER EVENTS SEQUENCE CONTROLLER PYRO
3	EDS POWER	EDS POWER

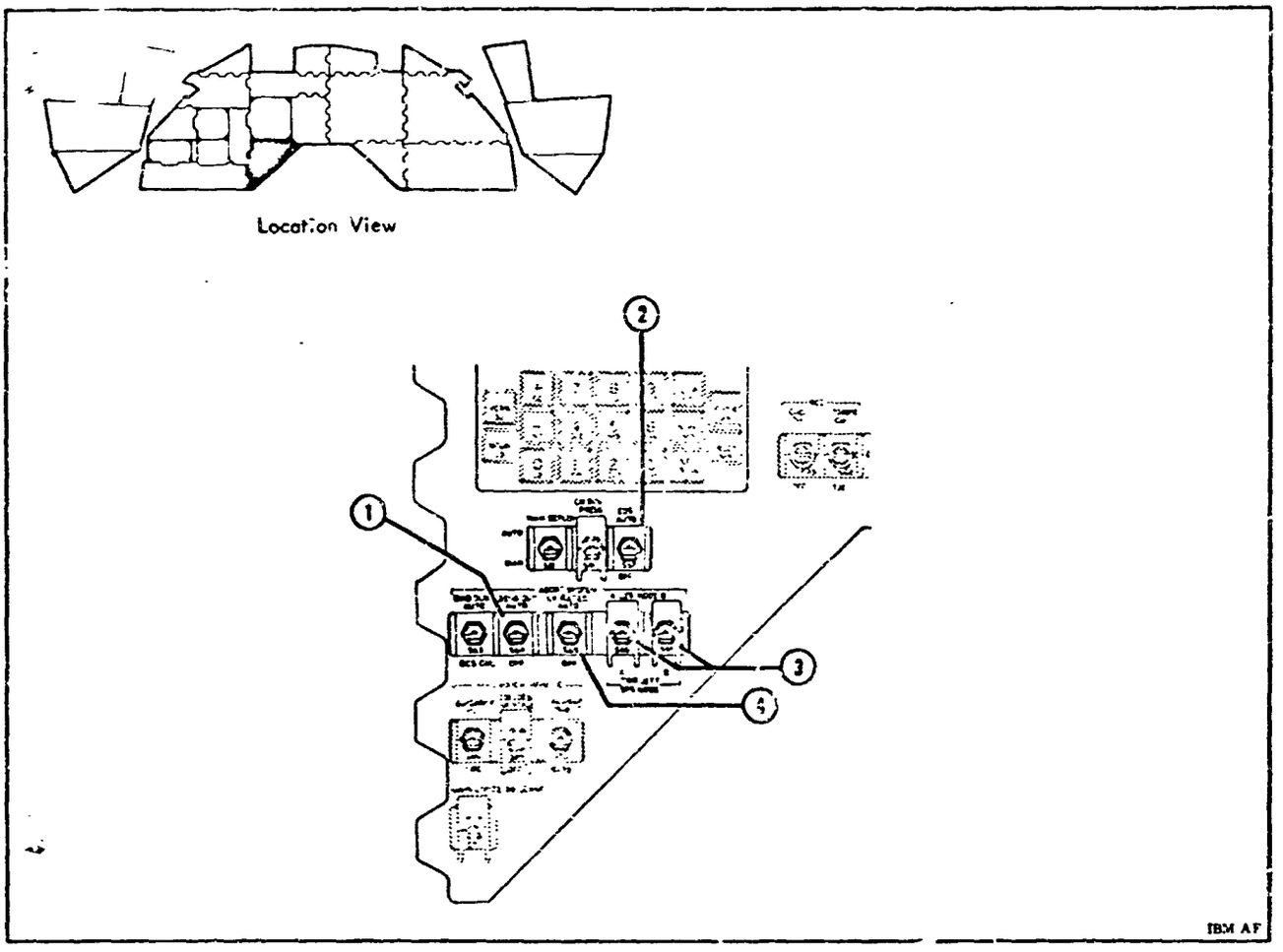


Figure 5-4. Crew Safety Controls, Block II (Center Console)

Legend for Figure 5-4

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	ABORT SYSTEM - 2 ENG OUT	S-IC TWO ENGINE OUT AUTO ABORT DEACTIVATE
2	EDS AUTO	AUTO ABORT ENABLE
3	ABORT SYSTEM - LES MODE - TWR JET SPS MODE	LET JETTISON
4	ABORT SYSTEM - LV RATES	RATE EXCESSIVE AUTO ABORT DEACTIVATE

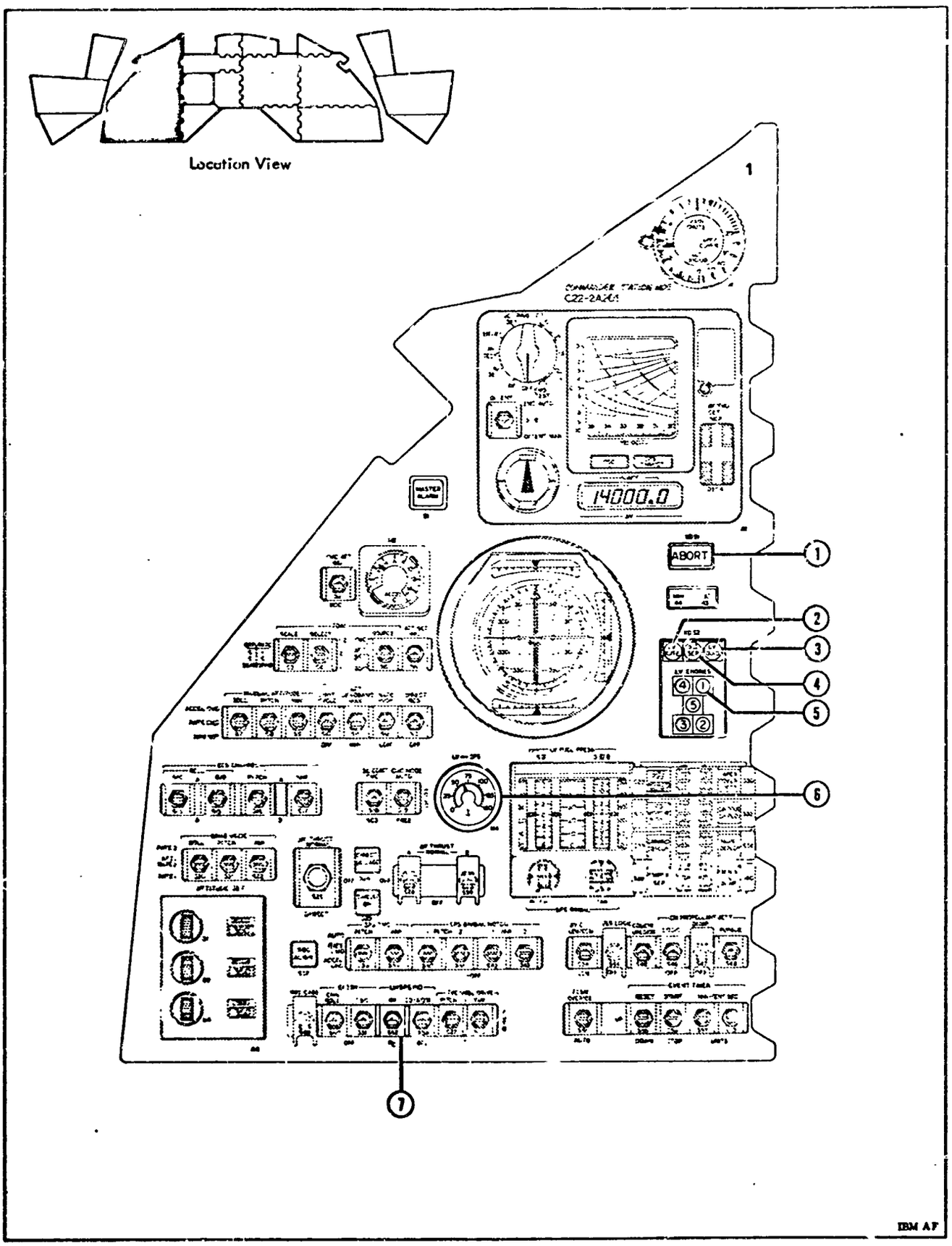
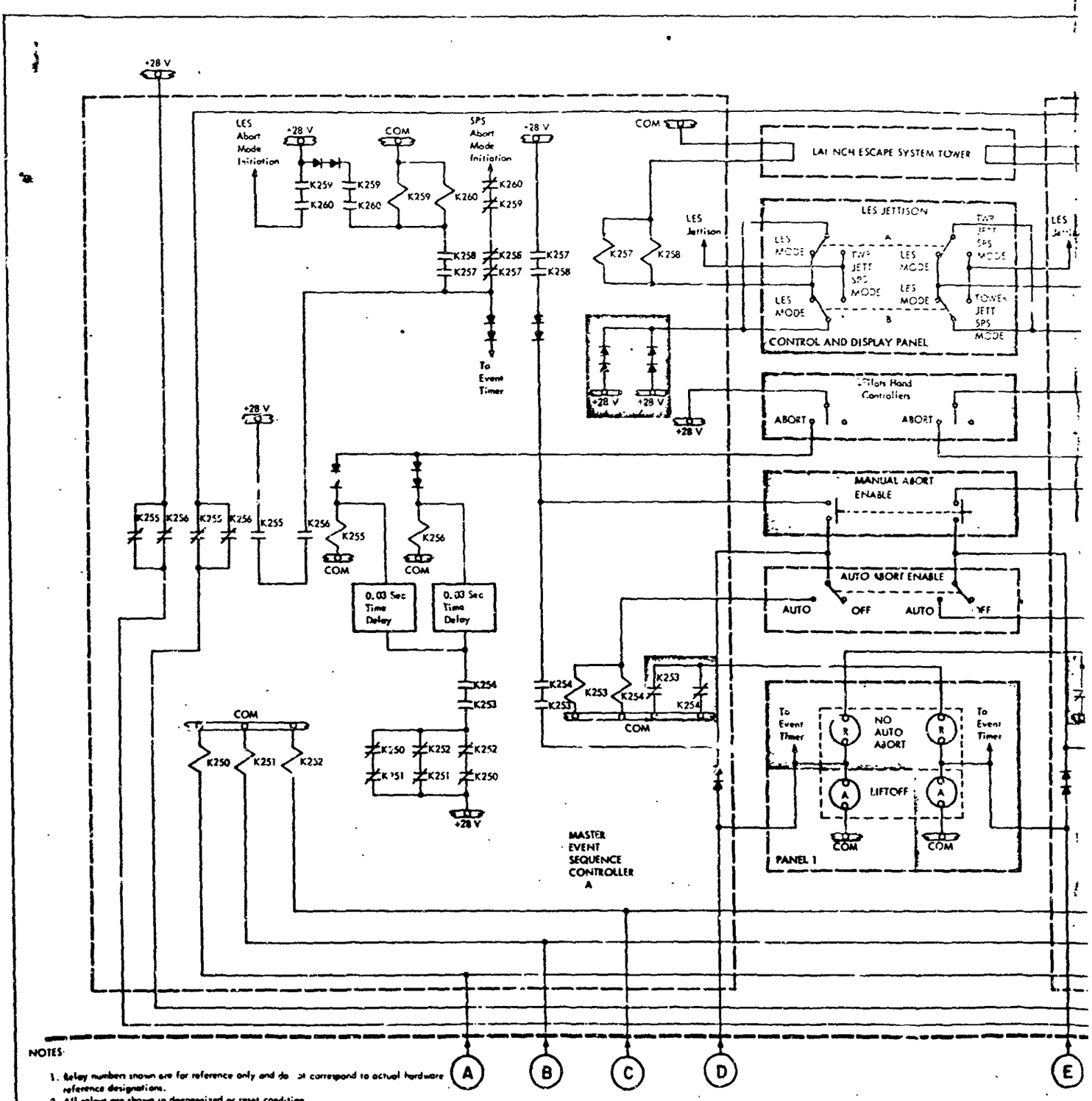


Figure 5-5. Mission Sequence Displays, Block II (Panel 1)

Legend for Figure 5-5

Index Number	Nomenclature on Panel	Nomenclature in Technical Manual
1	ABORT	ABORT REQUEST
2	LV RATE	LV RATE EXCESSIVE
3	LV GUID	LV ATT REF FAIL
4	S-II SEP	S-II SECOND PLANE SEPARATION
5	LV ENGINES	ENG NO. 1 OUT S-IC, S-II OR S-IVB (for indicator 1); Eng No. 2 thru 5 out S-IC and S-II.
6	LV α SPS P_c	Angle of Attack
7	LV/SPS IND — αP_c	LV A OF A – SPS PC



NOTES:

1. Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.
2. All relays are shown in deenergized or reset condition.
3. Reset buses can be energized only from Ground Support Equipment.
4. Wires between Command Module and Instrument Unit pass through Service Module and Lunar Excursion Module adapter.

Added 1 January

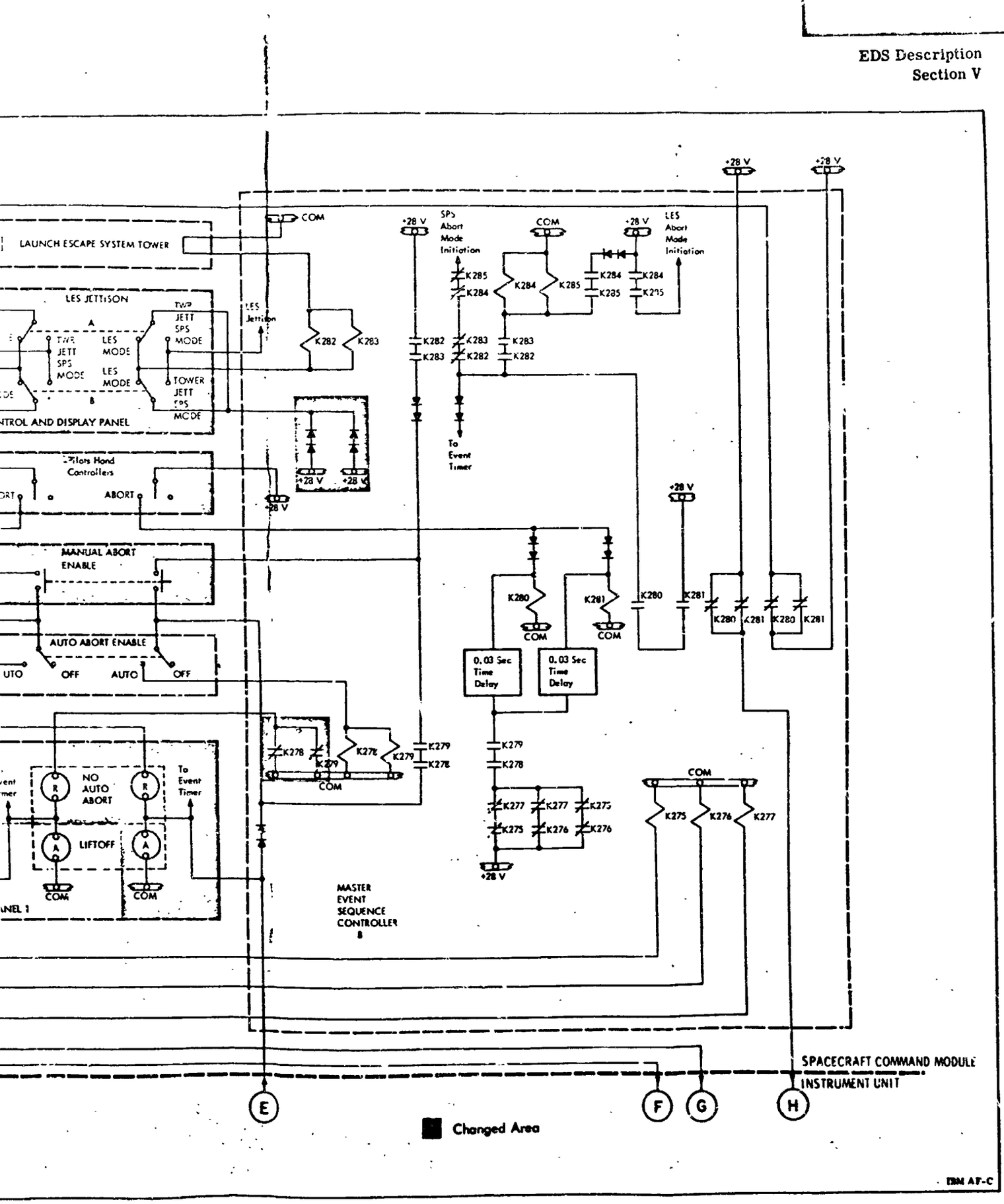


Figure 5-6
Abort Sequence Functional Schematic

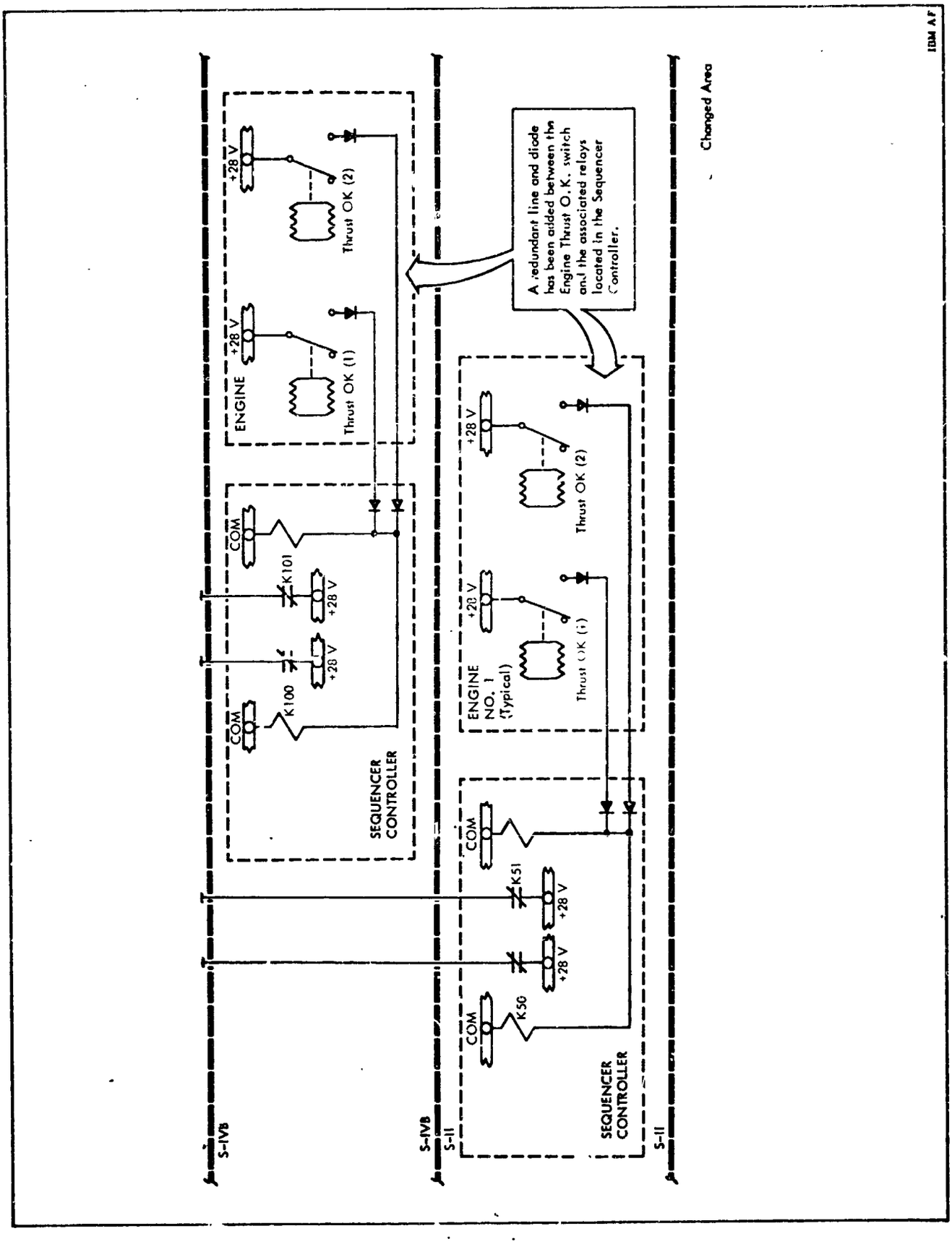


Figure 5-7. Engine Out Manual-Abort Indication Functional Schematic Modification Drawing

THE CONTENTS OF THE PRECEDING SECTIONS OF THIS MANUAL APPLY TO THE VEHICLE SPECIFIED ON THESE DATA SHEETS EXCEPT FOR THE FOLLOWING DIFFERENCES:

(IU) Figure 2-3, Angular Overrate Manual-Abort Indication Functional Schematic, has changed. Relays K171 through K174 have been deleted from the EDS Distributor, and the interconnecting leads between the EDS Distributor and the Control Signal Processor rate switches have been opened.

No angular overrate limit switching is possible.

GLOSSARY

COM	Common
EDS	Emergency Detection System
ENG	Engine
GSE	Ground Support Equipment
ICD	Interface Control Document
IU	Instrument Unit
JETT	Jettison
LES	Launch Escape System
LV	Launch Vehicle (Saturn portion of Apollo-Saturn vehicle)
MESC	Master Event Sequence Controller
Q-Ball	EDS Q-Ball Sensor System
SPS	Service Propulsion System
TM	Telemetry
TWR	Tower

APPENDIXES

Major portions of the EDS Interface Control Documents (ICD's) for Apollo-Saturn 500 Series Vehicles depicted on the title page have been included in the following Appendixes. The ICD's contain useful data that supplements the information in the preceding sections of this manual. Schematics in the ICD's provide more detail than the schematics in Section II. However, in some cases, the schematics in Section II contain later information than those in the ICD's. In addition to schematics, the ICD's include lists of relays and lists of the various +28 V buses required by the EDS.

The style and format of the material in the Appendix are not the same as those in the preceding sections of the manual. No attempt was made to restyle the content of the ICD's to conform to the manual style.

Inclusion of a complete ICD for each vehicle would have caused unnecessary duplications. Therefore, when a section in one ICD is duplicated in another ICD, that section is presented only once herein and referenced thereafter.

APPENDIX A *

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GEORGE C. MARSHALL SPACE FLIGHT CENTER

INTERFACE CONTROL DOCUMENT
DESCRIPTION OF SATURN SA-501 AND APOLLO SC-017
EMERGENCY DETECTION SYSTEM

I. INTRODUCTION

A. The purpose of this document is to describe the Apollo-Saturn SA-501 Emergency Detection System (EDS) design. The design is a coordinated effort by the Crew Safety Panel members and represents technical inputs from several NASA Centers and is binding on all participating centers. The system defined in this document conforms to the "Design Criteria for Saturn-V On-Board Emergency Detection System, ICD (#13M65001)." Paragraphs 1. through 2.b. are in accordance with 13M65001 and describe deviations from the criteria which are approved by the Panel for this unmanned development mission.

1. General Guidelines

a. Abort Sequence. The EDS in this mission will operate in an open loop mode. Automatic abort signals from the Launch Vehicle will be inhibited in the spacecraft.

b. Automatic Abort Activation. The liftoff signal will not activate the EDS automatic abort mode in this mission. The entire automatic abort signal will be interrupted in the spacecraft by leaving the Auto-Abort Enable Switch in the OFF position.

c. Manual Abort Considerations

(1) Manual abort from the spacecraft will not be feasible in this mission. Criteria for ground command abort will be determined by operational authority and are not within the scope of this document.

(2) Capability for ground activation of an abort request indicator circuit in the spacecraft will be provided. Activation of the circuit will be indicated by TM. Prior to liftoff, operation of the circuit will utilize hard-line to the instrument unit. After liftoff, only the

APOLLO INTERFACE DOCUMENT

* The ICD in this Appendix was dated December 25, 1965, and included no revisions.

Range Safety destruct system arming command to the S-IVB stage will be used to activate the circuit.

2. Emergency Detection Parameters for Automatic Abort

a. Angular Overrates.

(1) Automatic abort signal will be transmitted to the spacecraft, for telemetry only, when two of three gyros in any plane indicate that the rate limits are exceeded.

(2) Angular overrate (pitch, roll, yaw) signals will be deactivated by the launch vehicle sequencer prior to inboard engine cutoff enable.

b. S-V Two Engines Out. The loss of thrust on two or more engines will initiate an automatic abort signal which is transmitted to the spacecraft for telemetry only. This signal will be deactivated prior to inboard engine cutoff arming by the launch vehicle sequencer.

B. This document defines interfaces between modules and stages in functional terms only. Detailed interface information is contained in other interface documents. The document drawing numbers and other pertinent information may be obtained from the "Inter-Center Interface Control Document Log."

C. This document does not reflect all connections from other systems into the EDS circuits.

II. ABBREVIATIONS

For use with this document the following abbreviations shall apply:

1.	AUTO	Automatic
2.	BATT	Battery
3.	BME	Bench Maintenance Equipment
4.	CB	Circuit Breaker
5.	CMD	Command
6.	CO	Cutoff
7.	COM	Common Return
8.	COMB	Combustion
9.	COMP	Component

10.	CTL	Control
11.	DC	Direct Current
12.	DDAS	Digital Data Acquisition System
13.	DEACT	Deactivate
14.	DISCH	Discharge
15.	DISTR	Distributor
16.	EDS	Emergency Detection System
17.	ENG	Engine
18	FCM	Flight Combustion Monitor
19.	FWD	Forward
20.	GSE	Ground Support Equipment
21.	IND	Indication
22.	INSTR	Instrumentation
23.	IU	Instrument Unit
24.	JETT	Jettison
25.	LECO	Lox Engine Cutoff
26.	LES	Launch Escape System
27.	LET	Launch Escape Tower
28.	LH_2	Liquid Hydrogen
29.	LOX	Liquid Oxygen
30.	LV	Launch Vehicle
31.	MCP	Mission Control Programmer
32.	MEAS	Measurement
33.	MESC	Master Event Sequence Controller
34.	MS	Millisecond
35.	NC	Normally Closed
36.	NO	Normally Open
37.	No.	Number
38.	PRESS	Pressure
39.	PWR	Power
40.	RECIRC	Recirculation
41.	REQ	Request
42.	S	Switch
43.	SC	Spacecraft
44.	SEC	Second
45.	SEQ	Sequencer
46.	SPS	Service Propulsion System
47.	SUPV	Supervision
48.	TM	Telemetry

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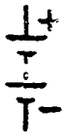
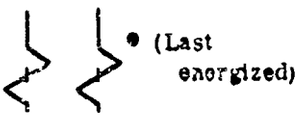
III. ELECTRICAL SYMBOLS

The electrical symbols used in this document are listed below.



Battery



Elect. Magnetic Latch Relay Coil

Diode or Rectifier

Electrical Relay Coil

Magnetic Latch
Normally Closed

Magnetic Latch
Normally Open

Solenoid

Normally Closed
Electrical Relay Contacts

Normally Open
Electrical Relay
Contacts

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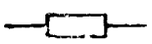


Resistor

Fuse

Amplifier

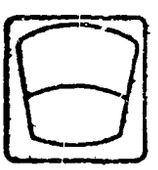
Transistor - NPN

Transistor - PNP

Indicating Lamp

Explosive Squib

Meter
(Biased)



Meter

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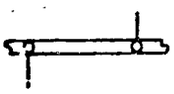
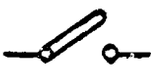
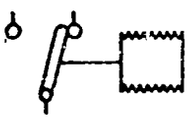


Bus

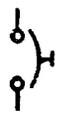
Terminal
Solder or Crimped



Single Throw Switch



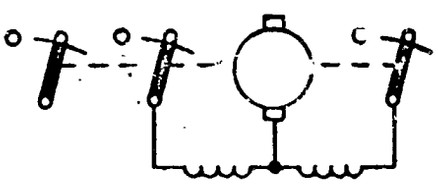
Pressure Switch
Transfer with Increase
in Pressure



Circuit Breaker

Double Throw Switch

Push Button
Switch/Maintained



Motor Switch

Bus/First Energized

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IV. INTERSTAGE SIGNALS

The method used in transmitting signals between stages will be as follows: If stage "A" requires a signal from stage "B" it will furnish stage "B" with a plus 28 volts, and stage "B" will switch the plus 28 volts and return the switched signal to stage "A". (See figure 1.) The plus 28 volts for signal transmission need only be furnished one time for a set of signals between stages. This method of transmitting signals allows the d.c. power of each stage to be completely independent and eliminates the problems of current transfer in the negative side of the d.c. power systems.

V. DESCRIPTION OF 28 VOLT BUSES

+1D10 The +1D10 bus is supplied directly from S-IC Battery Number One (115A10).

+1D11 The +1D11 bus is supplied from the +1D111 bus before power transfer or the +1D10 bus after power transfer.

+1D20 The +1D20 bus is supplied directly from S-IC Battery Number Two (115A20).

+1D21 The +1D21 bus is supplied from the +1D211 bus before power transfer or the +1D20 bus after power transfer.

+1D111 The +1D111 bus is supplied from the GSE networks and supplies the +1D11 bus during vehicle checkout and prelaunch sequence prior to power transfer.

+1D119 The +1D119 bus is supplied from the +1D119 supply in the GSE.

+1D211 The +1D211 bus is supplied from the GSE networks and supplies the +1D21 bus during vehicle checkout and prelaunch sequence prior to power transfer.

+2D11 The 2D11 bus is supplied from any of the following:

(a) GSE Regulated +28 VDC Main Power Supply before power transfer.
(b) S-II Main Battery 2071A1 after power transfer.
(c) GSE Main DC Power Supply before liftoff.

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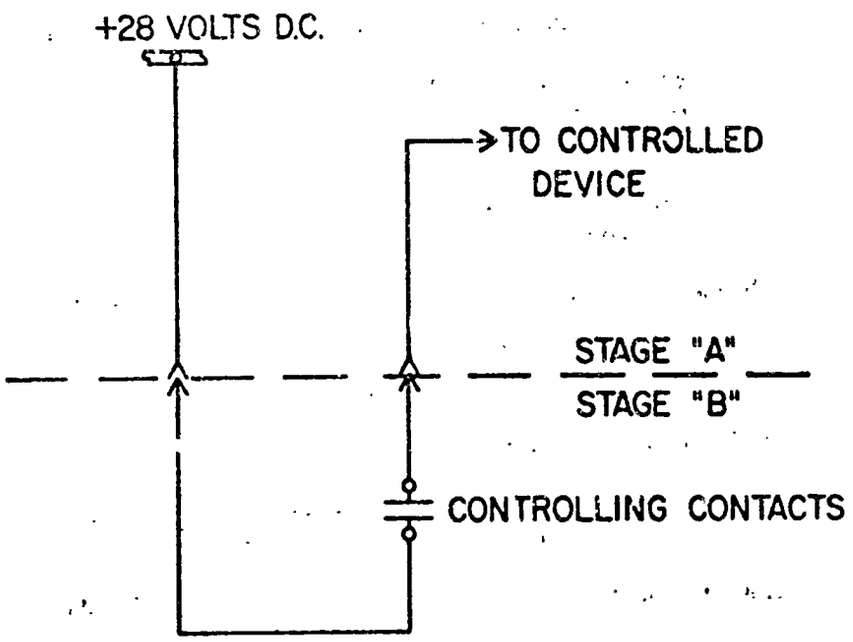

Figure 3. Interstage Signals

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+2D21 The +2D21 bus is supplied from any of the following:
(a) GSE Regulated +28 VDC Instrumentation Power Supply before power transfer.
(b) S-II Instrumentation Battery 207A1A2 after power transfer.
(c) GSE Instrumentation DC Power Supply before liftoff.

+4D11 The +4D11 bus is supplied from the +4D111 bus before power transfer or the +4D10 bus after power transfer.

+4D15 The +4D15 bus is supplied from the +4D11 bus after the S-IVB receives the "Sequencer Power ON Command" from GSE.

+4D31 The +4D31 bus is supplied from the +4D131 bus before power transfer or the +4D30 bus after power transfer.

+6D10 The +6D10 bus is supplied directly from the IU Battery 601A7.

+6D11 The +6D11 bus is supplied from the +6D111 bus before power transfer or the +6D10 bus after power transfer.

+6D30 The +6D30 bus is supplied directly from the IU Battery 601A9.

+6D31 The +6D31 bus is supplied from the +6D211 bus before power transfer or the +6D30 bus after power transfer.

+6D40 The +6D40 bus is supplied directly from the IU Battery 601A10.

+6D41 The +6D41 bus is supplied from the +6D211 bus before power transfer or the +6D40 bus after power transfer.

+6D91 The +6D91 bus is supplied from the +6D11 bus and is one of three EDS buses used in the IU for EDS circuitry.

+6D92 The +6D92 bus is supplied from the +6D31 bus and is one of three buses used in the IU for EDS circuitry.

+6D93 The +6D93 bus is supplied from the +6D41 bus and is one of three buses used in the IU for EDS circuitry.

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+6D119	The +6D119 bus is supplied to the IU from GSE.
Battery Bus A	Battery Bus A is supplied directly from the Apollo Entry Battery A.
Battery Bus B	Battery Bus B is supplied directly from the Apollo Entry Battery B.
EDS Bus No. 1	The EDS Bus No. 1 is supplied from Battery Bus A through a circuit breaker and the EDS power switch.
EDS Bus No. 2	The EDS bus No. 2 is supplied from Battery C through a circuit breaker and the EDS power switch.
EDS Bus No. 3	The EDS Bus No. 3 is supplied from the Battery Bus B through a circuit breaker and the EDS power switch.
EDS Change Over Bus A	The EDS Change Over Bus A energizes from EDS Bus No. 1 except when EDS Bus No. 1 fails (becomes de-energized) it automatically switches over to EDS Bus No. 2.
EDS Change Over Bus B	The EDS Change Over Bus B energizes from EDS Bus No. 3 except when EDS Bus No. 3 fails (becomes de-energized) it automatically switches over to EDS Bus No. 2.
Logic Bus A	Supplied from Battery Bus A through a circuit breaker and logic bus arm relay. This bus is armed or safed by the GSE operated logic bus arm relays and is used to activate the circuitry in MESC A.
Logic Bus B	Supplied from Battery Bus B through a circuit breaker and logic bus arm relay. This bus is armed or safed by the GSE operated logic bus arm relays and is used to activate the circuitry in MESC B.
Reset Bus No. 1	Supplied from the GSE networks and is used to reset critical EDS magnetic latch relays prior to launch. It may also be used during vehicle checkout to return these relays to their normal position.

Reset Bus No. 2	Supplied from the GSE networks and is used to reset critical EDS magnetic latch relays prior to launch. It may also be used during vehicle checkout to return these relays to their normal position.

VI. RELAY CROSS REFERENCE LIST

SATURN V
EDS RELAY FUNCTIONS

Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K1	S-IC Engine No. 1 Thrust Voting Relay A					2	2	2
K2	S-IC Engine No. 2 Thrust Voting Relay A					2	2	2
K3	S-IC Engine No. 3 Thrust Voting Relay A					2	2	2
K4	S-IC Engine No. 4 Thrust Voting Relay A					2	2	2
K5	S-IC Engine No. 5 Thrust Voting Relay A					2	2	2
K9-1	EDS Manual/Auto Cutoff of LV Engines A				4		3	3
K9-2	EDS Manual/Auto Cutoff of LV Engines A						7	3
K10-1	EDS Manual/Auto Cutoff of LV Engines B				4		3	3
K10-2	EDS Manual/Auto Cutoff of LV Engines B						7	3
K11	S-IC Engine No. 1 Thrust Voting Relay B						2	2
K12	S-IC Engine No. 2 Thrust Voting Relay B						2	2
K13	S-IC Engine No.3 Thrust Voting Relay B						2	2
K14	S-IC Engine No. 4 Thrust Voting Relay B						2	2
K15	S-IC Engine No. 5 Thrust Voting Relay B						2	2
K19-1	EDS or Manual Cutoff of LV Engines Armed A				3		2	2

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Relay #	Function	Contacts – Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K19-2	EDS or Manual Cutoff of LV Engines Armed B			3		2		2
K20-1	LV Engines Cutoff No. 1 from Apollo Spacecraft			3		3		6
K20-2	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	6
K20-3	LV Engines Cutoff No. 3 from Apollo Spacecraft			3		3		6
K20-4	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	6
K21-1	S-IC Engine No. 1 Thrust Monitor A						7	2
K21-2	S-IC Engine No. 1 Thrust Monitor B				7	2	2	2
K22-1	S-IC Engine No. 2 Thrust Monitor A				7	2	2	2
K22-2	S-IC Engine No. 2 Thrust Monitor B				7	2	2	2
K23-1	S-IC Engine No. 3 Thrust Monitor A				7	2	2	2
K23-2	S-IC Engine No. 3 Thrust Monitor B				7	2	2	2
K24-1	S-IC Engine No. 4 Thrust Monitor A				7	2	2	2
K24-2	S-IC Engine No. 4 Thrust Monitor B				7	2	2	2
K25-1	S-IC Engine No. 5 Thrust Monitor A				7	2	2	2
K25-2	S-IC Engine No. 5 Thrust Monitor B						7	2
K29-1	Auto Abort 1A to Apollo Spacecraft		10			10	10	10
K29-2	Auto Abort 1B to Apollo Spacecraft		10			10		10
K29-3	Auto Abort 2A to Apollo Spacecraft		10			10	10	10
K29-4	Auto Abort 2B to Apollo Spacecraft		10			10		10
K29-5	Auto Abort 3A to Apollo Spacecraft		10			10	10	10

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K29-6	Auto Abort 3B to Apollo Spacecraft			10		10		10
K30	+6D95 Monitor to GSE						10	10
K31-1	S-IC Engine No. 1 Thrust Monitor No. 1			3		2	3	2
K31-2	S-IC Engine No. 1 Thrust Monitor No. 2	3		3		2	3	2
K31-3	S-IC Engine No. 1 Thrust Monitor No. 3	3		3		2	3	2
K32-1	S-IC Engine No. 2 Thrust Monitor No. 1					2		
K32-2	S-IC Engine No. 2 Thrust Monitor No. 2					2		
K32-3	S-IC Engine No. 3 Thrust Monitor No. 3					2		
K33-1	S-IC Engine No. 3 Thrust Monitor No. 1					2		
K33-2	S-IC Engine No. 3 Thrust Monitor No. 2					2		
K33-3	S-IC Engine No. 3 Thrust Monitor No. 3					2		
K34-1	S-IC Engine No. 4 Thrust Monitor No. 1					2		
K34-2	S-IC Engine No. 4 Thrust Monitor No. 2					2		
K34-3	S-IC Engine No. 4 Thrust Monitor No. 3					2		
K35-1	S-IC Engine No. 5 Thrust Monitor No. 1					2		
K35-2	S-IC Engine No. 5 Thrust Monitor No. 2					2		
K35-3	S-IC Engine No. 5 Thrust Monitor No. 3					2		
K39	EDS Bus Changeover B					1	1	1
K40	Excessive Rate Auto Abort Inhibit (P, Y, & R)					6	6	6
K41	Excessive Rate Auto Abort Inhibit (Roll)					6	6	6
K42	S-IC Two Engine Out Auto Abort Inhibit					6	6	6

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K43-1	S-IC Two Engine Out Auto Abort Inhibit No. 1			2		2		6
K43-2	S-IC Two Engine Out Auto Abort Inhibit No. 2			2		2		6
K43-3	S-IC Two Engine Out Auto Abort Inhibit No. 3					2		6
K44	LET Jettisioned B1				9	9	9	9
K45	S-IVB Engine Thrust Monitor B					7		7
K46-1	Excessive Rate Auto Abort Inhibit (P & Y) No. 1			8		8	8	6
K46-2	Excessive Rate Auto Abort Inhibit (P & Y) No. 2					8		6
K46-3	Excessive Rate Auto Abort Inhibit (P & Y) No. 3					8		6
K47-1	Excessive Rate Auto Abort Inhibit (Roll) No. 1			8		8	8	6
K47-2	Excessive Rate Auto Abort Inhibit (Roll) No. 2					8		6
K47-3	Excessive Rate Auto Abort Inhibit (Roll) No. 3					8		6
K48	LET Jettisoned B2				9	9	9	9
K49	Range Safety Destruct Armed A from S-IVB				7		7	7
K50	Range Safety Destruct Armed B from S-IVB				7		7	7
K51	S-IVB Thrust Monitor A Indicator						7	7
K53	EDS Manual/Auto Cutoff A of S-IC Engines				3		3	3
K54-1	EDS Manual/Auto Cutoff B of S-IC Engines						3	3
K54-2	EDS Manual/Auto Cutoff B of S-IC Engines				3		3	3
K55	S-IC Engines Cutoff Enable						3	3
K56	S-IC Engines Cutoff Enable						3	3
K57	S-IVB Engine Start Command						6	6
K58	S-IVB Engine Prevent Start					6		6
K59	S-IC All Engines OK A					2		2

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Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K60	Excessive Roll Rate Voting Relay A				8		7	8
K61	Excessive Roll Rate Voting Relay B				8	8	7	8
K62	Excessive Pitch Rate Vo' Relay A				8		7	8
K63	Excessive Pitch Rate Voting Relay B				8	8	7	8
K64	Excessive Yaw Rate Voting Relay A				8		7	8
K65	Excessive Yaw Rate Voting Relay B				8	8	7	8
K66	EDS Arming of S-IVB Engine Thrust Indication A					7	7	7
K67	EDS Manual/Auto Cutoff A of S-IVB Engine				6		6	7
K68-1	S-II/S-IVB Separation Simulate					6		6
K68-2	S-II/S-IVB Separation Simulate					6		6
K69	Range Safety S-IVB Destruct Arm B				7		6	7
K70	Range Safety S-IVB Destruct Arm A				6		7	7
K71	Pad Abort Request				7		7	7
K72	S-IVB Thrust Monitor A					7		7
K73	EDS Bus Changeover A					1	1	1
K74	LES Abort Lock-Up Al				9	9	9	9
K75	LES Abort Lock-up A2				9	9	9	9
K76	Normal S-IVB Engine Cutoff						6	6
K77	EDS Manual/Auto Cutoff B of S-IVB Engine				6		6	7
K78	Cutoff S-IC Inboard Engine						3	3
K79	Cutoff S-IC Outboard Engine						3	3
K80	S-II All Engines Normal Cutoff						4	4
K81	S-II Engine No. 1 Thrust Monitor A						7	4
K82	S-II Engine No. 2 Thrust Monitor A						7	
K83	S-II Engine No. 3 Thrust Monitor A						7	
K84	S-II Engine No. 4 Thrust Monitor A						7	

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K85	S-II Engine No. 5 Thrust Monitor A						7	
K90	Auto-Abort System A Enable Inhibit					9		10
K91	Auto-Abort System B Enable Inhibit					9		10
K92	Auto-Abort System B Enable from GSE			10			9	10
K93	Auto-Abort System B Enable from GSE				10		9	10
K94-1	LV Attitude Reference Fail A						5	5
K94-2	LV Attitude Reference Fail B						5	5
K95	LET Jettisoned A1				9	9	9	9
K96	LET Jettisoned A2				9	9	9	9
K97	EDS Abort Voting Logic Input A1	10		9		9		10
K98	EDS Abort Voting Logic Input A2	10		9		9		10
K99	EDS Abort Voting Logic Input A3	10		9		9		10
K100	EDS Abort Voting Logic Input B1	10		9		9		10
K101	EDS Abort Voting Logic Input B2	10		9		9		10
K102	EDS Abort Voting Logic Input B3	10		9		9		10
K103	Abort B1			6		6	9	9
K104	Abort B2			6		6	9	9
K105	Abort A1			6		6	9	9
K106	Abort A2			6		6	9	9
K107	Auto-Abort System Enable A1		9		9	9	9	9
K108	Auto-Abort System Enable A2		9		9	9	9	9
K109	Auto-Abort System Enable B1		9		9	9	9	9
K110	Auto-Abort System Enable B2		9		9	9	9	9
K111	LES Abort Lock-up B1				9	9	9	9
K112	LES Abort Lock-up B2				9	9	9	9
K113	Excessive Rate Auto-Abort Inhibit (P, Y & R)					6	6	6
K114	Excessive Rate Auto-Abort Inhibit (Roll)					6	6	6

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K115	S-IC Two Engine Out Auto-Abort Inhibit					6	6	6
K116	+6D91 Bus GSE Disable					1		1
K117	+6D92 Bus GSE Disable					1		1
K118	+6D93 Bus GSE Disable					1		1
K119-1	Liftoff					10		10
K119-2	Liftoff					10		10
K121-1	S-II Engine No. 1 Thrust Monitor A (Type 1 of 5)			4		4		4
K121-2	S-II Engine No. 1 Thrust Monitor B (Type 1 of 5)					4		4
K122	Excessive Pitch Rate Output No. 1						8	8
K123	Excessive Pitch Relay Output No. 2						8	8
K124	Excessive Pitch Rate Output No. 3						8	8
K125	Excessive Yaw Rate Output No. 1						8	8
K126	Excessive Yaw Rate Output No. 2						8	8
K127	Excessive Yaw Rate Output No. 3						8	8
K128	Excessive Roll Rate Output No. 1						8	8
K129	Excessive Roll Rate Output No. 2						8	8
K130	Excessive Roll Rate Output No. 3						8	8
K131	RF Link Abort Request A						7	7
K132	RF Link Abort Request B						7	7
K134	S-IVB Thrust OK Monitor B Indication						7	7
K135-1	Rate Gyro High Rate on A1				8		8	6
K135-2	Rate Gyro High Rate on A2						8	6
K136-1	Rate Gyro High Rate on B1			8		8		6
K136-2	Rate Gyro High Rate on B2			7		8		6
K137	Logic A Bus Arm A						1	1
K138	Logic A Bus Arm B						1	1
K139	Logic B Bus Arm A						1	1

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K140	Logic B Bus Arm B						1	1
K145	LET Jettison A				10		10	10
K146	LET Jettison B				10		10	10
K147	S-IC Engine No. 1 Rough Combustion Voting Relay						3	3
K148	S-IC Engine No. 2 Rough Combustion Voting Relay B				3		3	3
K149	S-II Second Plane Separation Simulate			5		5		5
K150	S-II LH_2 Prevalves Close Command						4	4
K151	S-II Engine No. 1 Thrust Monitor B							4
K152	S-II Engine No. 2 Thrust Monitor B						7	
K153	S-II Engine No. 3 Thrust Monitor B						7	
K154	S-II Engine No. 4 Thrust Monitor B						7	
K155	S-II Engine No. 5 Thrust Monitor B						7	
K156	S-II Range Safety No. 1 Engines Cutoff				4		4	4
K157	S-II Range Safety No. 2 Engines Cutoff				4		4	4
K158	S-IC Engine No. 1 Prevalves Close				3		3	3
K159	S-IC Engine No. 1 Cutoff				3		3	3
K160	EDS Manual/Auto Cutoff A of S-II Engines				4	4	4	4
K161	EDS Manual/Auto Cutoff B of S-II Engines				4	4	4	4
K162-1	S-II LH_2 Prevalves Close Command from Engines Prevent Start						4	4
K162-2	S-II LH_2 Prevalves Close Command from Engines Prevent Start							4

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Relay #	Function	Contacts - Schematic Sheet No. NC	NC	NC	NO	NC	NO	Coil
K162-3	S-II LH_2 Prevalves Close Command from Engines Prevent Start							4
K163	S-II Start Phase Limiter Cutoff Arm						4	4
K166	Engine Start Interlock By-pass						6	6
K167	EDS Arming of S-IVB Engine Thrust Indication B					7	7	7
K171	GSE Engine Thrust Indication Enable A			7		7		7
K172	GSE Engine Thrust Indication Enable B			7		7		7
K173	EDS Arming of S-II Thrust Indication A				5	7	4	4
K174	EDS Arming of S-II Thrust Indication B				5	7	4	4
K182-1	RF Abort A1					10	9	10
K182-2	RF Abort A2						9	10
K183-1	RF Abort B1					10	9	10
K183-2	RF Abort B2						9	10
K192-1	LET Jettison A1					9	9	10
K192-2	LET Jettison A2					9	9	10
K193-1	LET Jettison B1					9	9	10
K193-2	LET Jettison B2					9	9	10
K198	S-IVB Prevalve Control Command						6	6
K199	S-IVB Chill Down Shutoff Command						6	6
K201-1	S-II Second Plane Separation A						5	5
K201-2	S-II Second Plane Separation B						5	5
K202	S-IC Range Safety Engines Cutoff A				3		3	3
K203-1	S-IC Range Safety Engines Cutoff B1				3		3	3
K203-2	S-IC Range Safety Engines Cutoff B2						3	3
K206-1	MESC Logic Bus A Arm A						1	1
K206-2	MESC Logic Bus A Arm B						1	1
K207-1	MESC Logic Bus B Arm A						1	1

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K208	S-II Engine No. 1 Cutoff					4	4	4
K212	Timers Test				2		6	6
K214	Normal S-II Engines Cutoff B				4		4	4
K215	Normal S-II Engines Cutoff A				4		4	4
K216	S-II All Engines Start Command						4	4
K217	S-II Engines Prevent Start					4		4
K218	S-II Engines Prevent Start By-pass Command					4		4
K219	S-IC All Engines OK B					2		2

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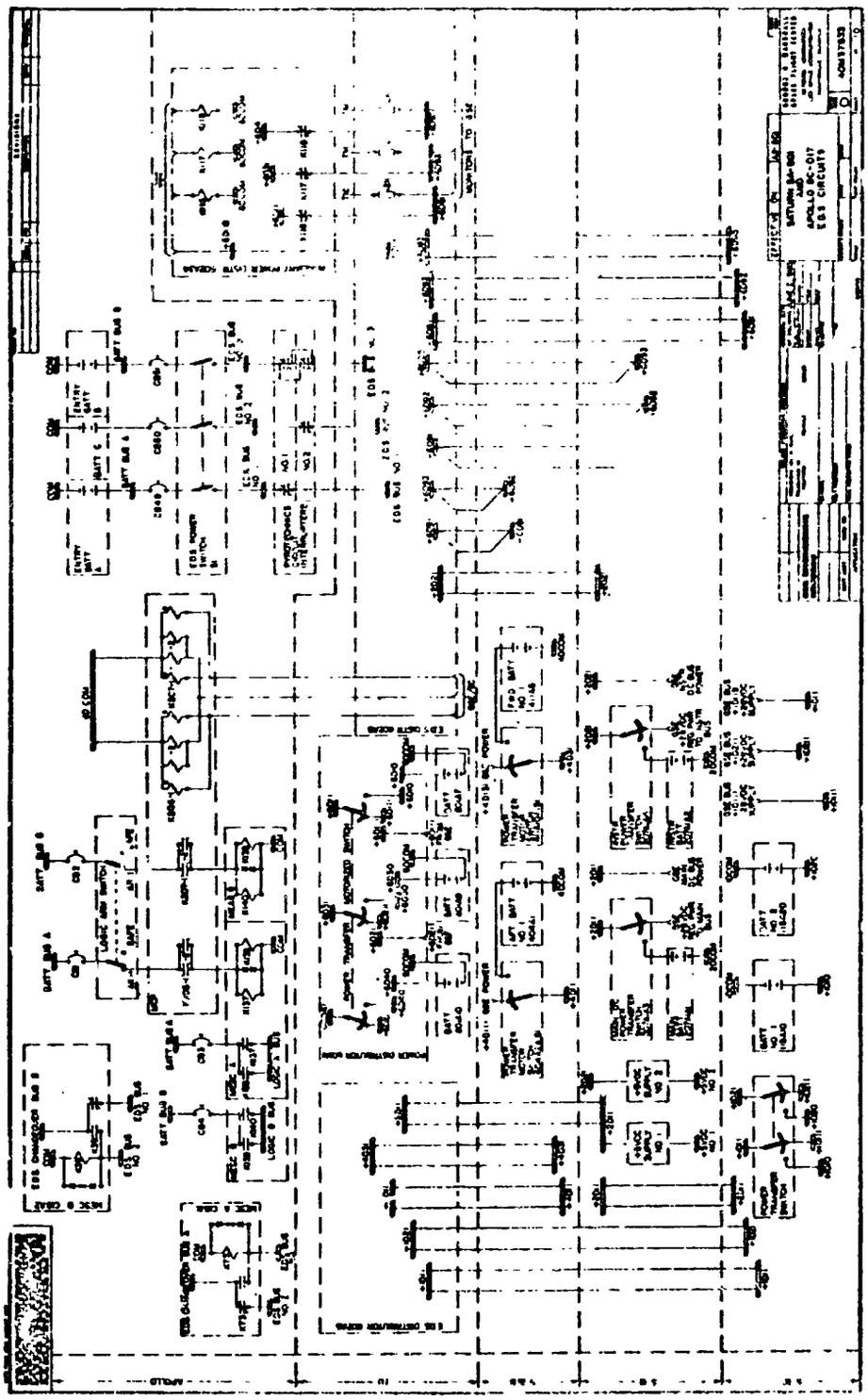
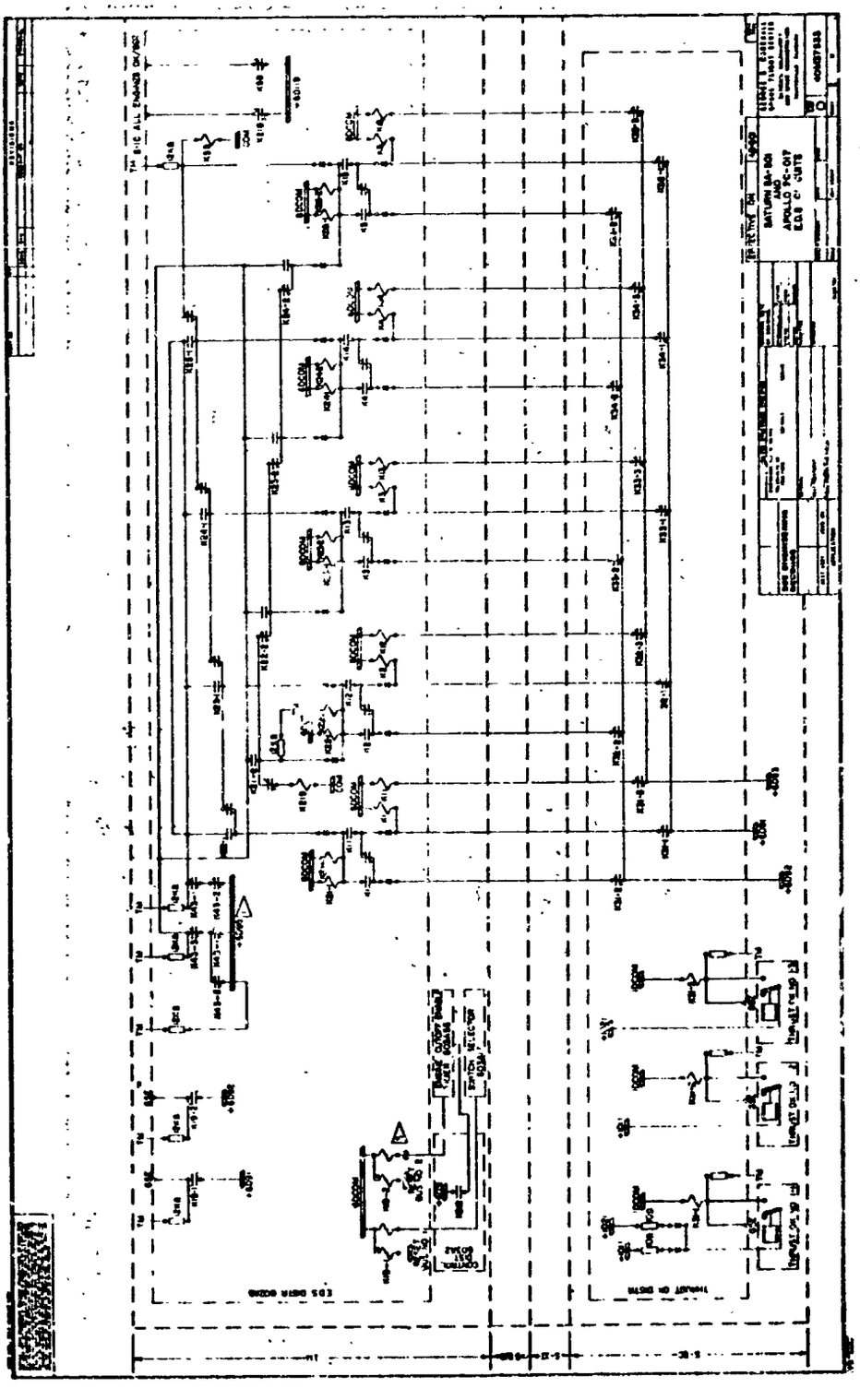
DRAWING NOTES:

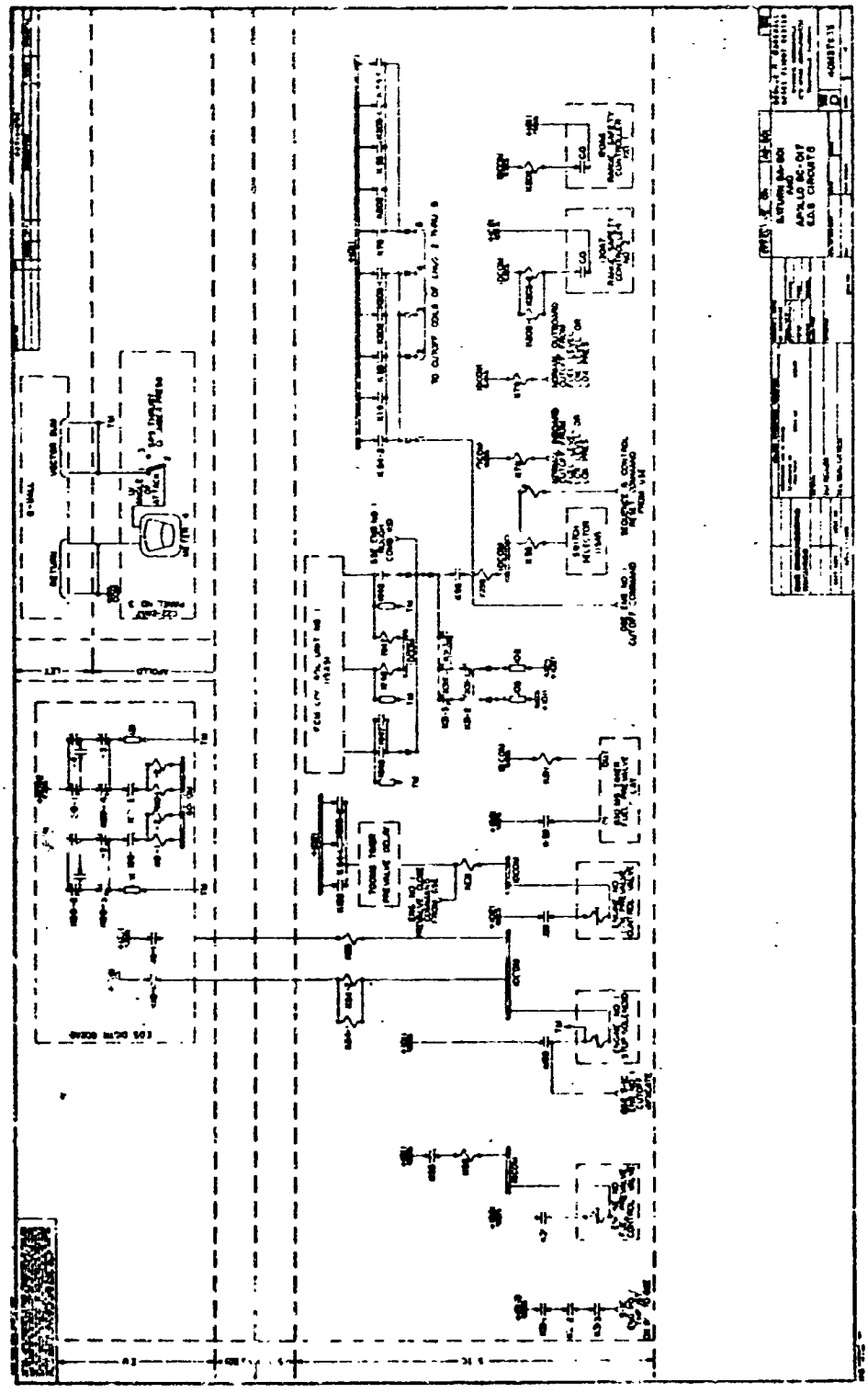
1. The Auto-Abort bus can be energized from the excessive rate circuit as well as the two Engine Out Circuit on Page 2.

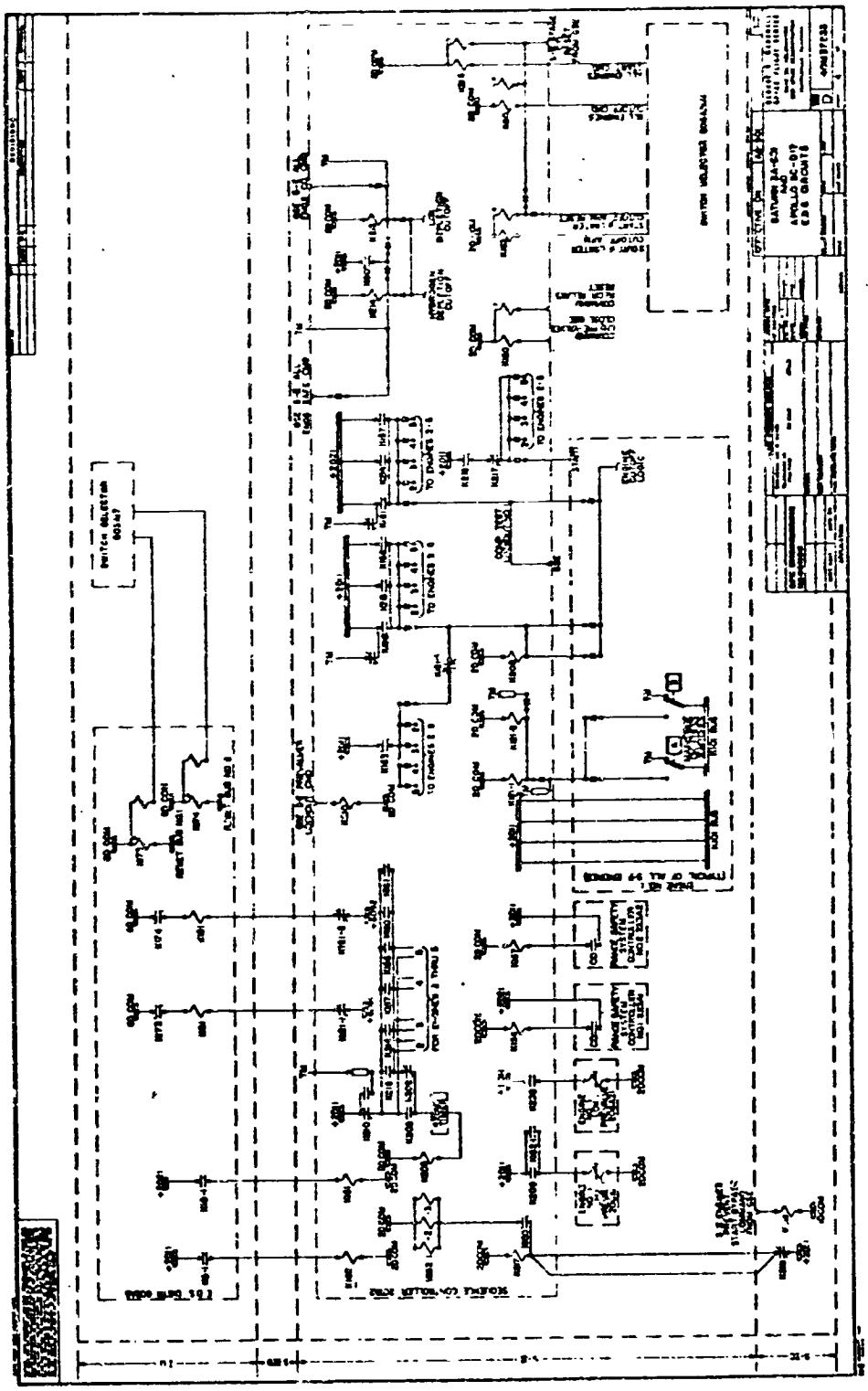
2. This function is not programmed on the switch selector for this mission.

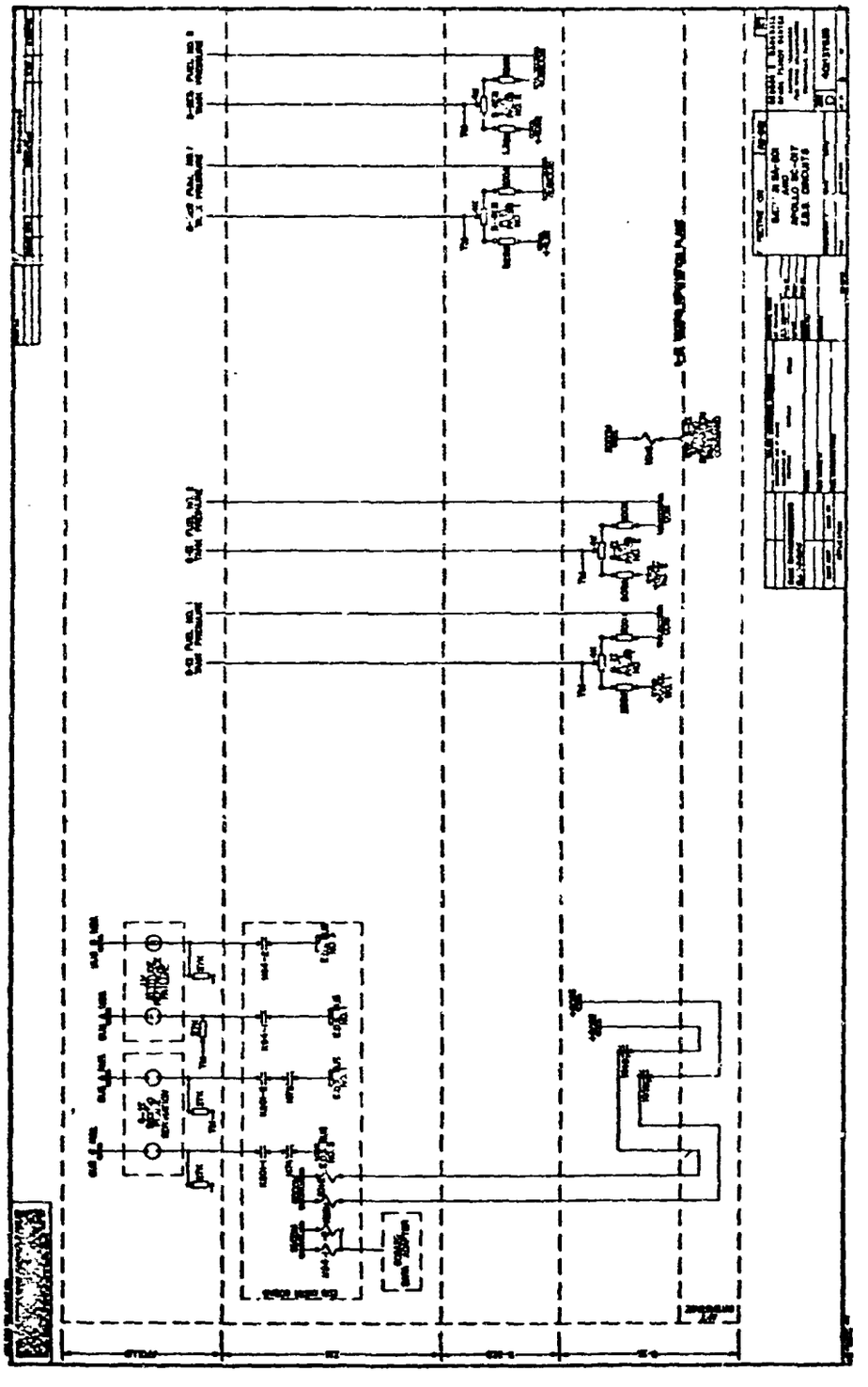
3. This circuit is not active on this mission and the function is inhibited.

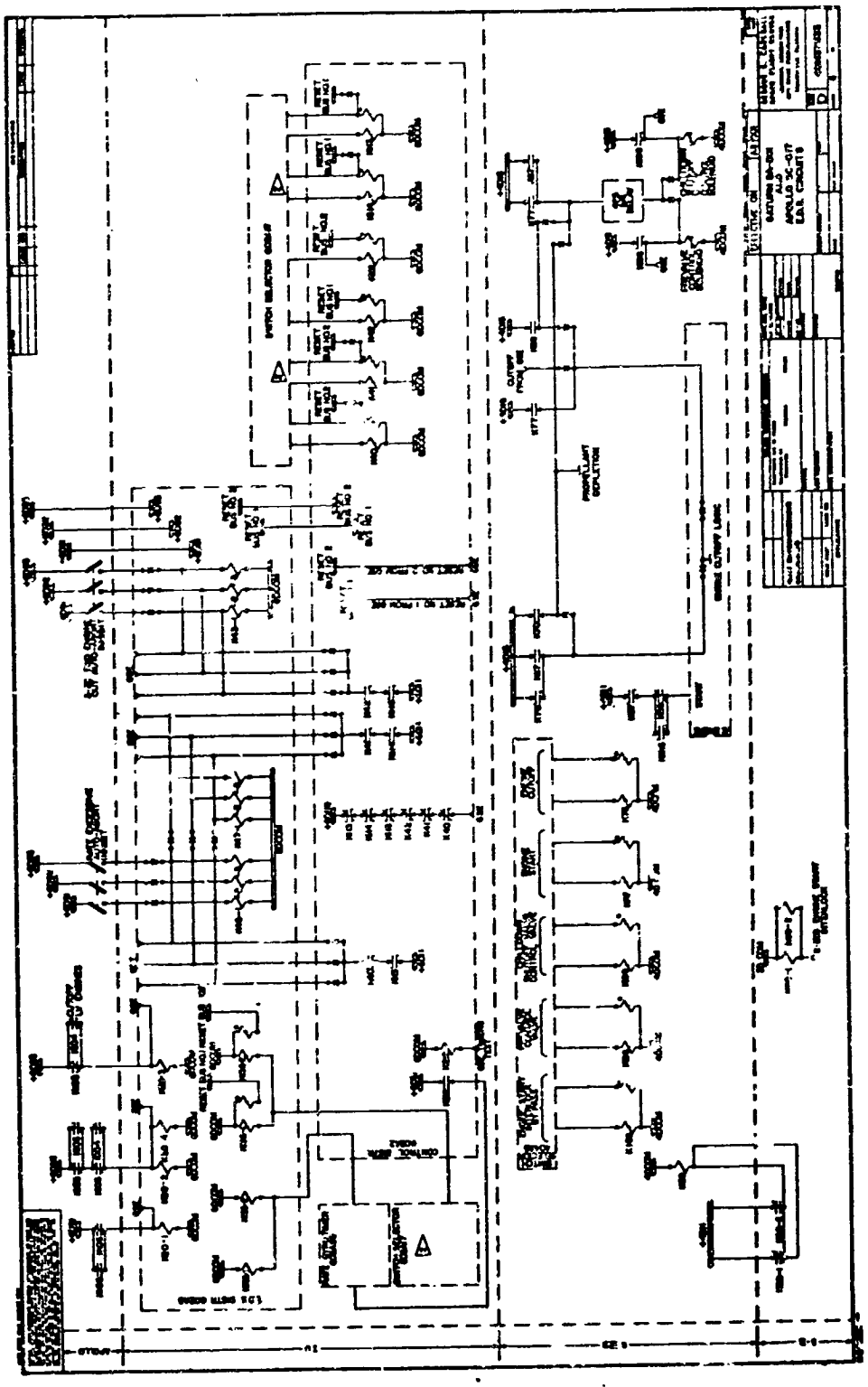


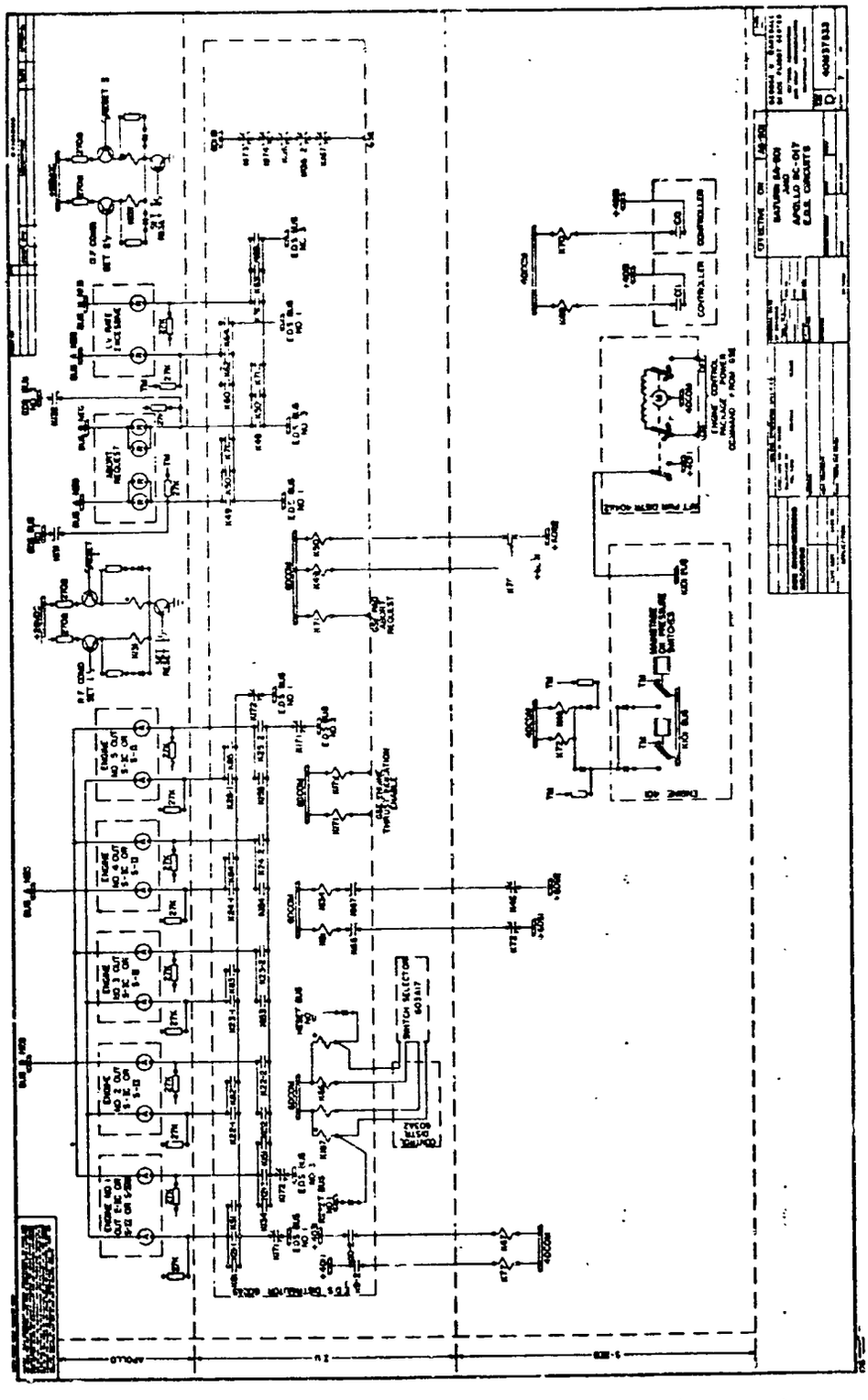


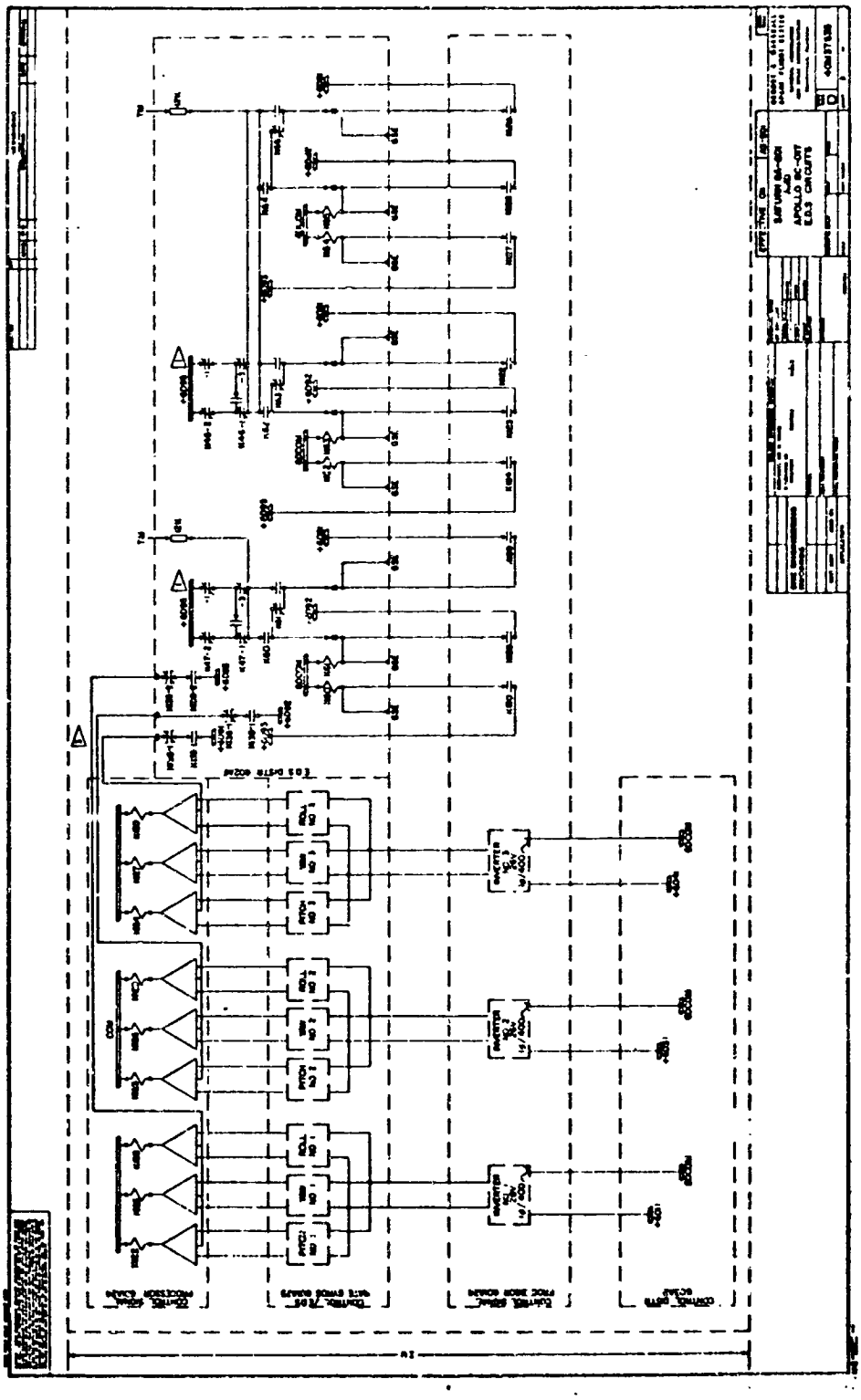


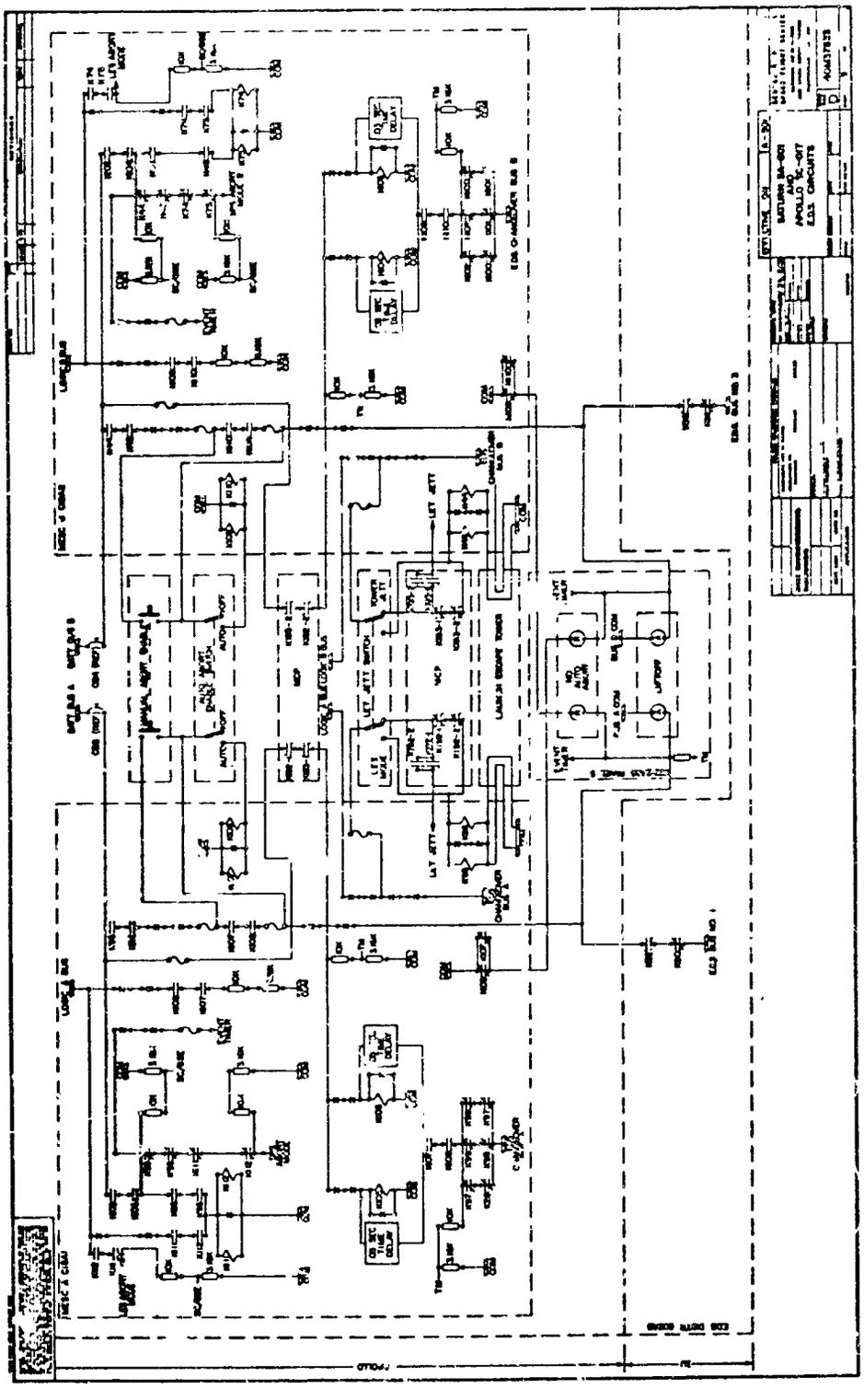


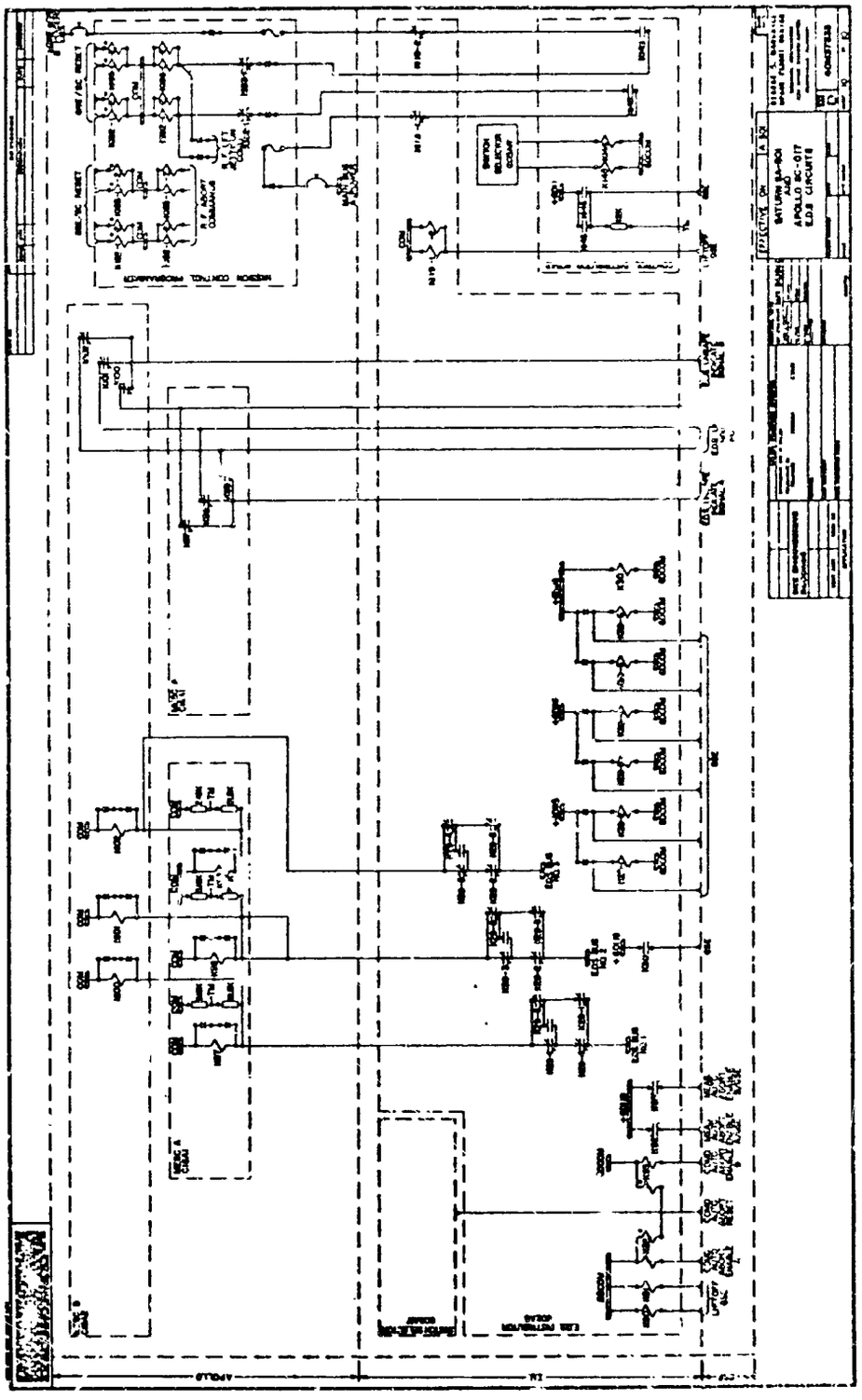












APPENDIX B*

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GEORGE C. MARSHALL SPACE FLIGHT CENTER

INTERFACE CONTROL DOCUMENT
DESCRIPTION OF SATURN SA-502 AND APOLLO SC-020
EMERGENCY DETECTION SYSTEM

I. INTRODUCTION

A. The purpose of this document is to describe the Apollo-Saturn SA-502 Emergency Detection System (EDS) design. The design is a coordinated effort by the Crew Safety Panel members and represents technical inputs from several NASA Centers and is binding on all participating centers. The system defined in this document conforms to the "Design Criteria for Saturn-V On-Board Emergency Detection System, ICD (#13M65001)." Paragraphs 1. through 2.b. are in accordance with 13M65001 and describe deviations from the criteria which are approved by the Panel for this unmanned development mission.

1. General Guidelines

a. Abort Sequence. The EDS in this mission will operate in an open loop mode. Automatic abort signals from the Launch Vehicle will be inhibited in the spacecraft.

b. Automatic Abort Activation. The liftoff signal will not activate the EDS automatic abort mode in this mission. The entire automatic abort signal will be interrupted in the spacecraft by leaving the Auto-Abort Enable Switch in the OFF position.

c. Manual Abort Considerations

(1) Manual abort from the spacecraft will not be feasible in this mission. Criteria for ground command abort will be determined by operational authority and are not within the scope of this document.

(2) Capability for ground activation of an abort request indicator circuit in the spacecraft will be provided. Activation of the circuit will be indicated by TM. Prior to liftoff, operation of the circuit will utilize hard-line to the instrument unit. After liftoff, only the

APOLLO INTERFACE DOCUMENT

* The ICD in this Appendix was dated December 30, 1965, and included no revisions. Pages of the ICD that were modified for this Appendix do not retain the ICD drawing number.

Range Safety destruct system arming command to the S-IVB stage will be used to activate the circuit.

2. Emergency Detection Parameters for Automatic Abort

a. Angular Overrates.

(1) Automatic abort signal will be transmitted to the spacecraft, for telemetry only, when two of three gyros in any plane indicate that the rate limits are exceeded.

(2) Angular overrate (pitch, roll, yaw) signals will be deactivated by the launch vehicle sequencer prior to inboard engine cutoff enable.

b. S-V Two Engines Out. The loss of thrust on two or more engines will initiate an automatic abort signal which is transmitted to the spacecraft for telemetry only. This signal will be deactivated prior to inboard engine cutoff arming by the launch vehicle sequencer.

B. This document defines interfaces between modules and stages in functional terms only. Detailed interface information is contained in other interface documents. The document drawing numbers and other pertinent information may be obtained from the "Inter-Center Interface Control Document Log."

C. This document does not reflect all connections from other systems into the EDS circuits.

II ABBREVIATIONS

(Refer to Section II in Appendix A)

III ELECTRICAL SYMBOLS

(Refer to Section III in Appendix A)

IV INTERSTAGE SIGNALS

(Refer to Section IV in Appendix A)

V DESCRIPTION OF 28 VOLT BUSES

(Refer to Section V in Appendix A)

VI RELAY CROSS REFERENCE LIST
SATURN V
EDS Relay Functions

NOTE: Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K1	S-IC Engine No. 1 Thrust Voting Relay A					2	2	2
K2	S-IC Engine No. 2 Thrust Voting Relay A					2	2	2
K3	S-IC Engine No. 3 Thrust Voting Relay A					2	2	2
K4	S-IC Engine No. 4 Thrust Voting Relay A					2	2	2
K5	S-IC Engine No. 5 Thrust Voting Relay A					2	2	2
K9-1	EDS Manual/Auto Cutoff of LV Engines A				4		3	3
K9-2	EDS Manual/Auto Cutoff of LV Engines A						7	3
K10-1	EDS Manual/Auto Cutoff of LV Engines B				4		3	3
K10-2	EDS Manual/Auto Cutoff of LV Engines B						7	3
K11	S-IC Engine No. 1 Thrust Voting Relay B						2	2
K12	S-IC Engine No. 2 Thrust Voting Relay B						2	2
K13	S-IC Engine No.3 Thrust Voting Relay B						2	2
K14	S-IC Engine No. 4 Thrust Voting Relay B						2	2
K15	S-IC Engine No. 5 Thrust Voting Relay B						2	2
K19-1	EDS or Manual Cutoff of LV Engines Armed A				3		2	2

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K19-2	EDS or Manual Cutoff of LV Engines Armed B				3		2	2
K20-1	LV Engines Cutoff No. 1 from Apollo Spacecraft			3		3		6
K20-2	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	6
K20-3	LV Engines Cutoff No. 3 from Apollo Spacecraft			3		3		6
K20-4	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	6
K21-1	S-IC Engine No. 1 Thrust Monitor A						7	2
K21-2	S-IC Engine No. 1 Thrust Monitor B				7	2	2	2
K22-1	S-IC Engine No. 2 Thrust Monitor A				7	2	2	2
K22-2	S-IC Engine No. 2 Thrust Monitor B				7	2	2	2
K23-1	S-IC Engine No. 3 Thrust Monitor A				7	2	2	2
K23-2	S-IC Engine No. 3 Thrust Monitor B				7	2	2	2
K24-1	S-IC Engine No. 4 Thrust Monitor A				7	2	2	2
K24-2	S-IC Engine No. 4 Thrust Monitor B				7	2	2	2
K25-1	S-IC Engine No. 5 Thrust Monitor A				7	2	2	2
K25-2	S-IC Engine No. 5 Thrust Monitor B						7	2
K29-1	Auto Abort 1A to Apollo Spacecraft			10		10	10	10
K29-2	Auto Abort 1B to Apollo Spacecraft			10		10		10
K29-3	Auto Abort 2A to Apollo Spacecraft			10		10	10	10
K29-4	Auto Abort 2B to Apollo Spacecraft			10		10		10
K29-5	Auto Abort 3A to Apollo Spacecraft			10		10	10	10

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Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K29-6	Auto Abort 3B to Apollo Spacecraft			10		10		10
K30	+6D95 Monitor to GSE						10	10
K31-1	S-IC Engine No. 1 Thrust Monitor No. 1			3		2	3	2
K31-2	S-IC Engine No. 1 Thrust Monitor No. 2	3		3		2	3	2
K31-3	S-IC Engine No. 1 Thrust Monitor No. 3	3		3			3	2
K32-1	S-IC Engine No. 2 Thrust Monitor No. 1					2		
K32-2	S-IC Engine No. 2 Thrust Monitor No. 2					2		
K32-3	S-IC Engine No. 3 Thrust Monitor No. 3					2		
K33-1	S-IC Engine No. 3 Thrust Monitor No. 1					2		
K33-2	S-IC Engine No. 3 Thrust Monitor No. 2					2		
K33-3	S-IC Engine No. 3 Thrust Monitor No. 3					2		
K34-1	S-IC Engine No. 4 Thrust Monitor No. 1					2		
K34-2	S-IC Engine No. 4 Thrust Monitor No. 2					2		
K34-3	S-IC Engine No. 4 Thrust Monitor No. 3					2		
K35-1	S-IC Engine No. 5 Thrust Monitor No. 1					2		
K35-2	S-IC Engine No. 5 Thrust Monitor No. 2					2		
K35-3	S-IC Engine No. 5 Thrust Monitor No. 3					2		
K39	EDS Bus Changeover B					1	1	2
K40	Excessive Rate Auto Abort Inhibit (P, Y, & R)					6	6	6
K41	Excessive Rate Auto Abort Inhibit (Roll)					6	6	6
K42	S-IC Two Engine Out Auto Abort Inhibit					6	6	6

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Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K43-1	S-IC Two Engine Out Auto Abort Inhibit No. 1			2		2		6
K43-2	S-IC Two Engine Out Auto Abort Inhibit No. 2			2		2		6
K43-3	S-IC Two Engine Out Auto Abort Inhibit No. 3					2		6
K44	LET Jettisoned B1				9	9	9	9
K45	S-IVB Engine Thrust Monitor B					7		7
K46-1	Excessive Rate Auto Abort Inhibit (P & Y) No. 1			8		8	8	6
K46-2	Excessive Rate Auto Abort Inhibit (P & Y) No. 2					8		6
K46-3	Excessive Rate Auto Abort Inhibit (P & Y) No. 3					8		6
K47-1	Excessive Rate Auto Abort Inhibit (Roll) No. 1			8		8	8	6
K47-2	Excessive Rate Auto Abort Inhibit (Roll) No. 2					8		6
K47-3	Excessive Rate Auto Abort Inhibit (Roll) No. 3					8		6
K48	LET Jettisoned B2				9	9	9	9
K49	Range Safety Destruct Armed A from S-IVB				7		7	7
K50	Range Safety Destruct Armed B from S-IVB				7		7	7
K51	S-IVB Thrust Monitor A Indicator						7	7
K53	EDS Manual/Auto Cutoff A of S-IC Engines				3		3	3
K54-1	EDS Manual/Auto Cutoff B of S-IC Engines						3	3
K54-2	EDS Manual/Auto Cutoff B of S-IC Engines				3		3	3
K55	S-IC Engines Cutoff Enable						3	3
K56	S-IC Engines Cutoff Enable						3	3
K57	S-IVB Engine Start Command						6	6
K58	S-IVB Engine Prevent Start					6		6
K59	S-IC All Engines OK A					2		2

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Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K60	Excessive Roll Rate Voting Relay A				8		7	8
K61	Excessive Roll Rate Voting Relay B				8	8	7	8
K62	Excessive Pitch Rate Voting Relay A				8		7	8
K63	Excessive Pitch Rate Voting Relay B				8	8	7	8
K64	Excessive Yaw Rate Voting Relay A				8		7	8
K65	Excessive Yaw Rate Voting Relay B				8	8	7	8
K66	EDS Arming of S-IVB Engine Thrust Indication A					7	7	7
K67	EDS Manual/Auto Cutoff A of S-IVB Engine				6		8	7
K68-1	S-II/S-IVB Separation Simulate					6		6
K68-2	S-II/S-IVB Separation Simulate					6		6
K69	Range Safety S-IVB Destruct Arm B				7		6	7
K70	Range Safety S-IVB Destruct Arm A				6		7	7
K71	Pad Abort Request				7		7	7
K72	S-IVB Thrust Monitor A					7		7
K73	EDS Bus Changeover A					1	1	1
K74	LES Abort Lock-Up A1				9	9	9	9
K75	LES Abort Lock-up A2				9	9	9	9
K76	Normal S-IVB Engine Cutoff						6	6
K77	EDS Manual/Auto Cutoff B of S-IVB Engine				6		6	7
K78	Cutoff S-IC Inboard Engine						3	3
K79	Cutoff S-IC Outboard Engine						3	3
K80	S-II All Engines Normal Cutoff						4	4
K81	S-II Engine No. 1 Thrust Monitor A						7	4
K82	S-II Engine No. 2 Thrust Monitor A						7	
K83	S-II Engine No. 3 Thrust Monitor A						7	
K84	S-II Engine No. 4 Thrust Monitor A						7	

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K85	S-II Engine No. 5 Thrust Monitor A						7	
K90	Auto-Abort System A Enable Inhibit					9		10
K91	Auto-Abort System B Enable Inhibit					9		10
K92	Auto-Abort System B Enable from GSE			10			9	10
K93	Auto-Abort System B Enable from GSE				10		9	10
K94-1	LV Attitude Reference Fail A						5	5
K94-2	LV Attitude Reference Fail B						5	5
K95	LET Jettisoned A1				9	9	9	9
K96	LET Jettisoned A2				9	9	9	9
K97	EDS Abort Voting Logic Input A1	10		9		9		10
K98	EDS Abort Voting Logic Input A2	10		9		9		10
K99	EDS Abort Voting Logic Input A3	10		9		9		10
K100	EDS Abort Voting Logic Input B1	10		9		9		10
K101	EDS Abort Voting Logic Input B2	10		9		9		10
K102	EDS Abort Voting Logic Input B3	10		9		9		10
K103	Abort B1			6		6	9	9
K104	Abort B2			6		6	9	9
K105	Abort A1			6		6	9	9
K106	Abort A2			6		6	9	9
K107	Auto-Abort System Enable A1		9		9	9	9	9
K108	Auto-Abort System Enable A2		9		9	9	9	9
K109	Auto-Abort System Enable B1		9		9	9	9	9
K110	Auto-Abort System Enable B2		9		9	9	9	9
K111	LES Abort Lock-up B1				9	9	9	9
K112	LES Abort Lock-up B2				9	9	9	9
K113	Excessive Rate Auto-Abort Inhibit (P, Y & R)					6	6	6
K114	Excessive Rate Auto-Abort Inhibit (Roll)					6	6	6

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K115	S-IC Two Engine Out Auto-Abort Inhibit					6	6	6
K116	+6D91 Bus GSE Disable					1		1
K117	+6D92 Bus GSE Disable					1		1
K118	+6D93 Bus GSE Disable					1		1
K119-1	Liftoff					10		10
K119-2	Liftoff					10		10
K121-1	S-II Engine No. 1 Thrust Monitor A (Type 1 of 5)			4		4		4
K121-2	S-II Engine No. 1 Thrust Monitor B (Type 1 of 5)					4		4
K122	Excessive Pitch Rate Output No. 1						8	8
K123	Excessive Pitch Relay Output No. 2						8	8
K124	Excessive Pitch Rate Output No. 3						8	8
K125	Excessive Yaw Rate Output No. 1						8	8
K126	Excessive Yaw Rate Output No. 2						8	8
K127	Excessive Yaw Rate Output No. 3						8	8
K128	Excessive Roll Rate Output No. 1						8	8
K129	Excessive Roll Rate Output No. 2						8	8
K130	Excessive Roll Rate Output No. 3						8	8
K131	RF Link Abort Request A						7	7
K132	RF Link Abort Request B						7	7
K134	S-IVB Thrust OK Monitor B Indication						7	7
K135-1	Rate Gyro High Rate on A1				8		8	6
K135-2	Rate Gyro High Rate on A2						8	6
K136-1	Rate Gyro High Rate on B1			8		8		6
K136-2	Rate Gyro High Rate on B2			7		8		6
K137	Logic A Bus Arm A						1	1
K138	Logic A Bus Arm B						1	1
K139	Logic B Bus Arm A						1	1

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Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NC	NC	NO	NC	NO	Coil
K140	Logic B Bus Arm B						1	1
K145	LET Jettison A				10		10	10
K146	LET Jettison B				10		10	10
K147	S-IC Engine No. 1 Rough Combustion Voting Relay						3	3
K148	S-IC Engine No. 2 Rough Combustion Voting Relay B				3		3	3
K149	S-II Second Plane Separation Simulate			5		5		5
K150	S-II LH_2 Prevalves Close Command						4	4
K151	S-II Engine No. 1 Thrust Monitor B						7	4
K152	S-II Engine No. 2 Thrust Monitor B						7	
K153	S-II Engine No. 3 Thrust Monitor B						7	
K154	S-II Engine No. 4 Thrust Monitor B						7	
K155	S-II Engine No. 5 Thrust Monitor B						7	
K156	S-II Range Safety No. 1 Engines Cutoff				4		4	4
K157	S-II Range Safety No. 2 Engines Cutoff				4		4	4
K158	S-IC Engine No. 1 Prevalves Close				3		3	3
K159	S-IC Engine No. 1 Cutoff				3		3	3
K160	EDS Manual/Aut. Cutoff A of S-II Engines				4	4	4	4
K161	EDS Manual/Aut. Cutoff B of S-II Engines				4	4	4	4
K162-1	S-II LH_2 Prevalves Close Command from Engines Prevent Start						4	4
K162-2	S-II LH_2 Prevalves Close Command from Engines Prevent Start							4

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Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K162-3	S-II LH_2 Prevalves Close Command from Engines Prevent Start							4
K163	S-II Start Phase Limiter Cutoff Arm						4	4
K166	Engine Start Interlock By-pass						6	6
K167	EDS Arming of S-IVB Engine Thrust Indication B					7	7	7
K171	GSE Engine Thrust Indication Enable A			7		7		7
K172	GSE Engine Thrust Indication Enable B			7		7		7
K173	EDS Arming of S-II Thrust Indication A				5	7	4	4
K174	EDS Arming of S-II Thrust Indication B				5	7	4	4
K182-1	RF Abort A1					10	9	10
K182-2	RF Abort A2						9	10
K183-1	RF Abort B1					10	9	10
K183-2	RF Abort B2						9	10
K192-1	LET Jettison A1					9	9	10
K192-2	LET Jettison A2					9	9	10
K193-1	LET Jettison B1					9	9	10
K193-2	LET Jettison B2					9	9	10
K198	S-IVB Prevalve Control Command						6	6
K199	S-IVB Hill Down Shutoff Command						6	6
K201-1	S-II Second Plane Separator A						5	5
K201-2	S-II Second Plane Separation B						5	5
K202	S-IC Range Safety Engines Cutoff A				3		3	3
K203-1	S-IC Range Safety Engines Cutoff B1				3		3	3
K203-2	S-IC Range Safety Engines Cutoff B2						3	3
K206-1	MESC Logic Bus A Arm A						1	1
K206-2	MESC Logic Bus A Arm B						1	1
K207-1	MESC Logic Bus B Arm A						1	1

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K208	S-II Engine No. 1 Cutoff					4	4	4
K212	Timers Test				2		6	6
K214	Normal S-II Engines Cutoff B				4		4	4
K215	Normal S-II Engines Cutoff A				4		4	4
K216	S-II All Engines Start Command						4	4
K217	S-II Engines Prevent Start					4		4
K218	S-II Engines Prevent Start By-pass Command					4		4
K219	S-IC All Engines OK B					2		2

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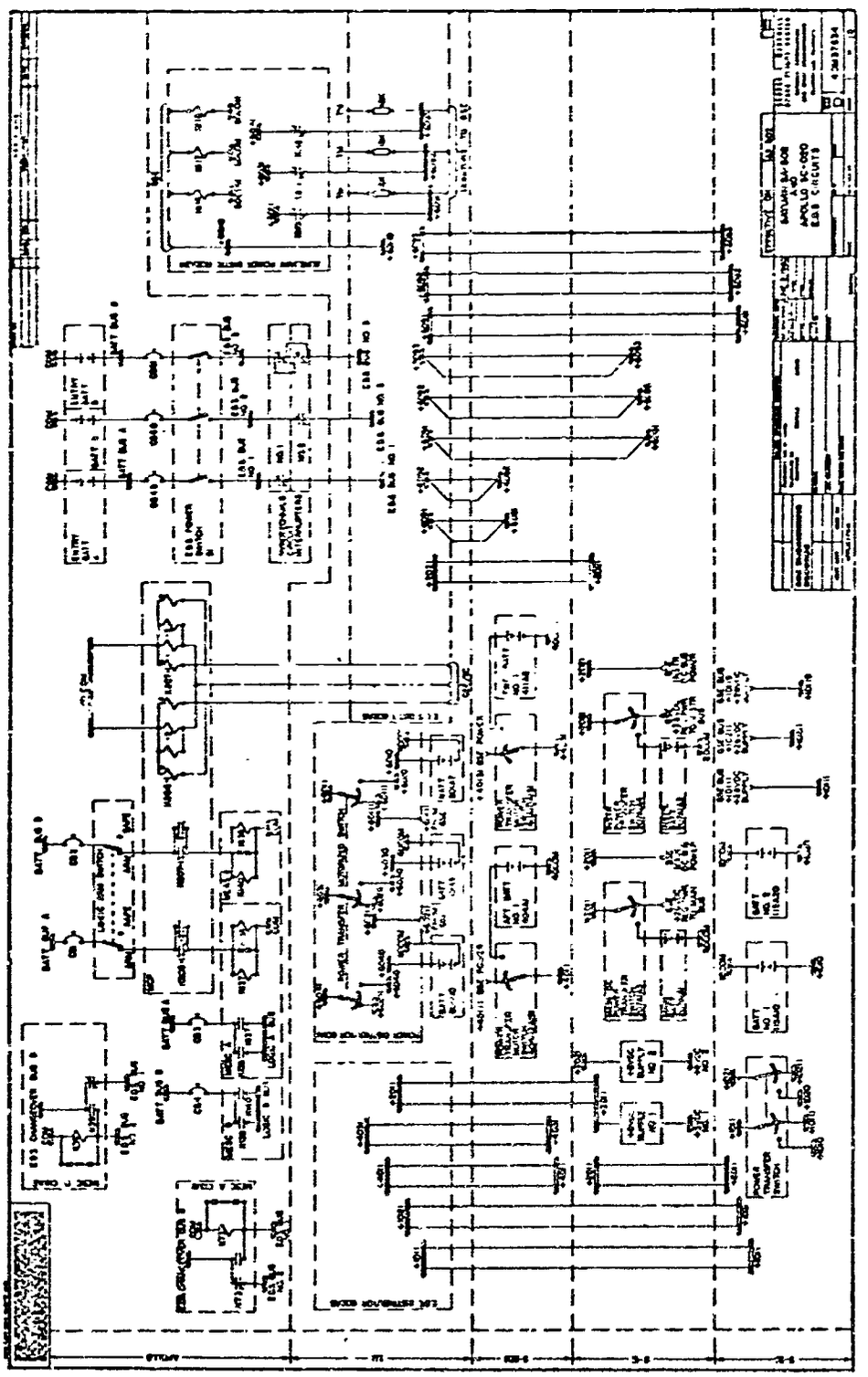
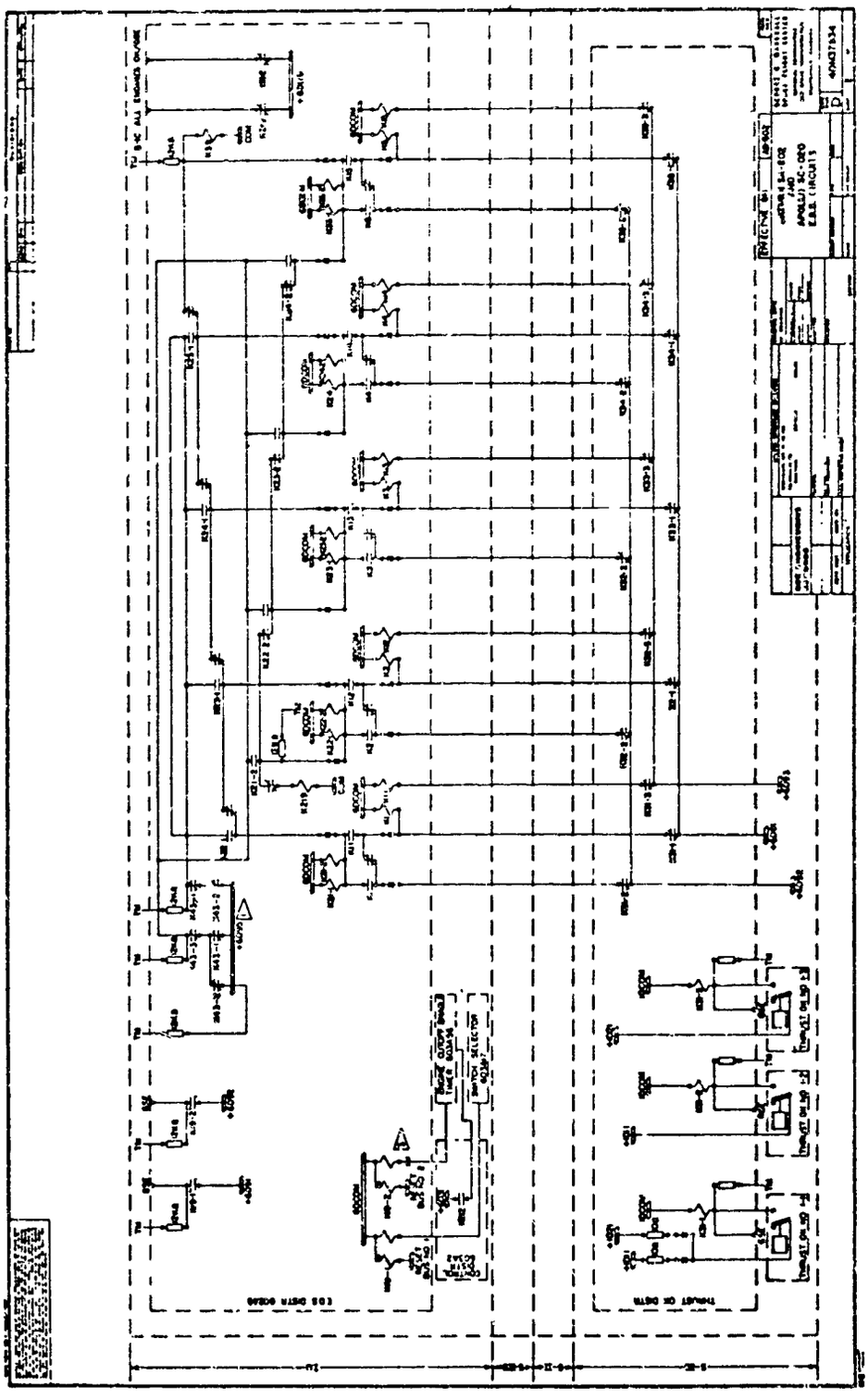
DRAWING NOTES:

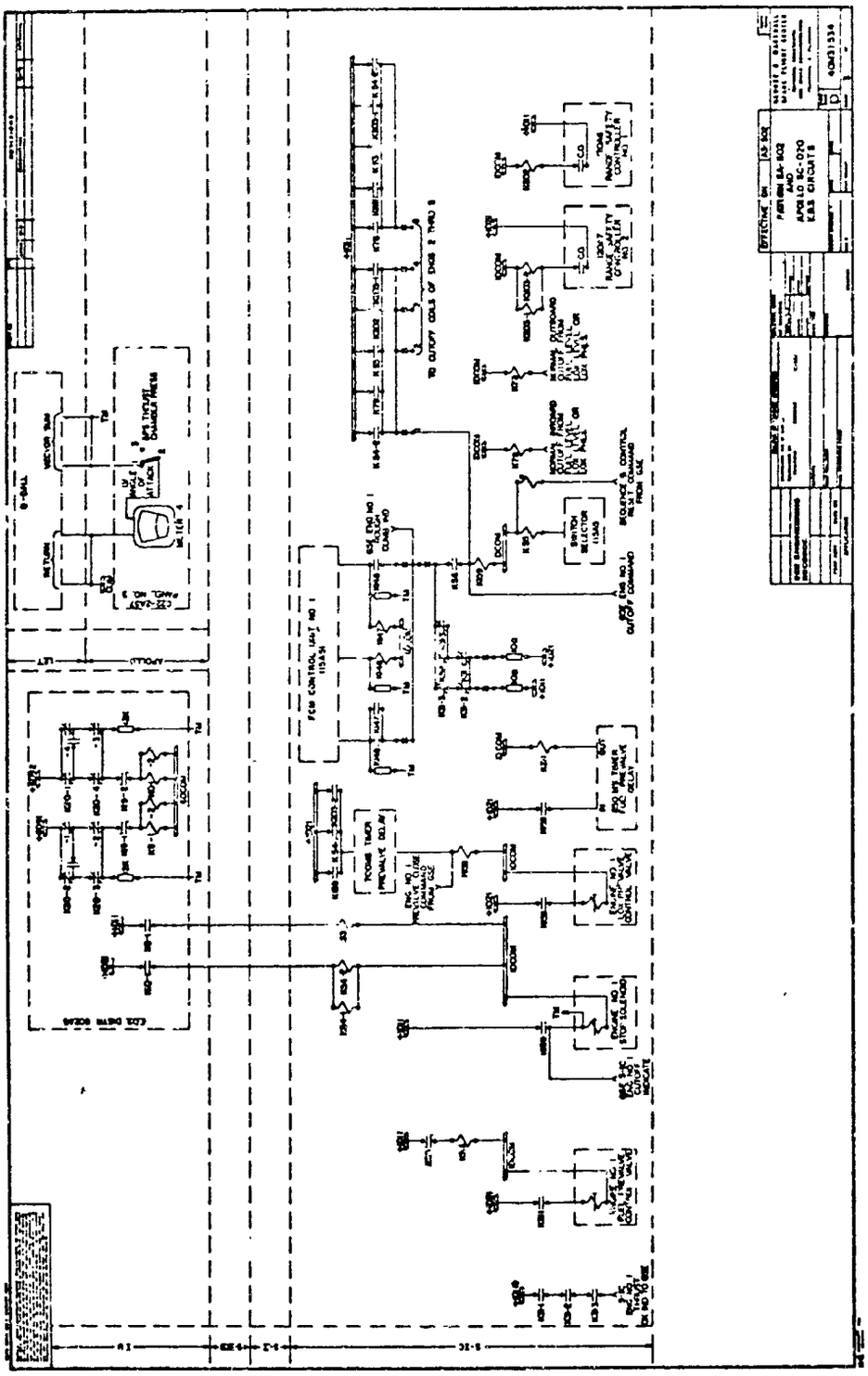
1. The Auto-Abort bus can be energized from the excessive rate circuit as well as the two Engine Out Circuit on Page 2.

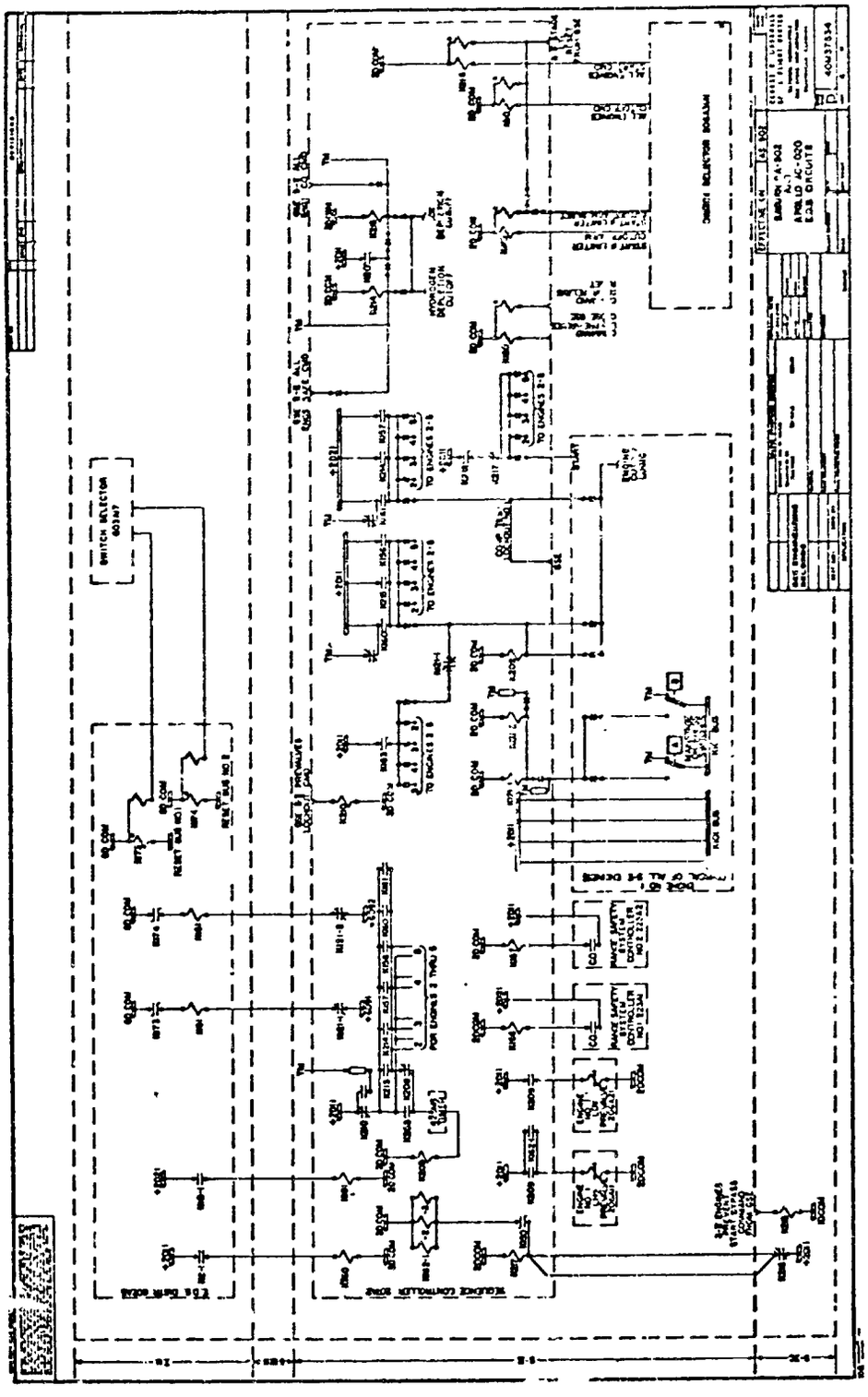
2. This function is not programmed on the switch selector for this mission.

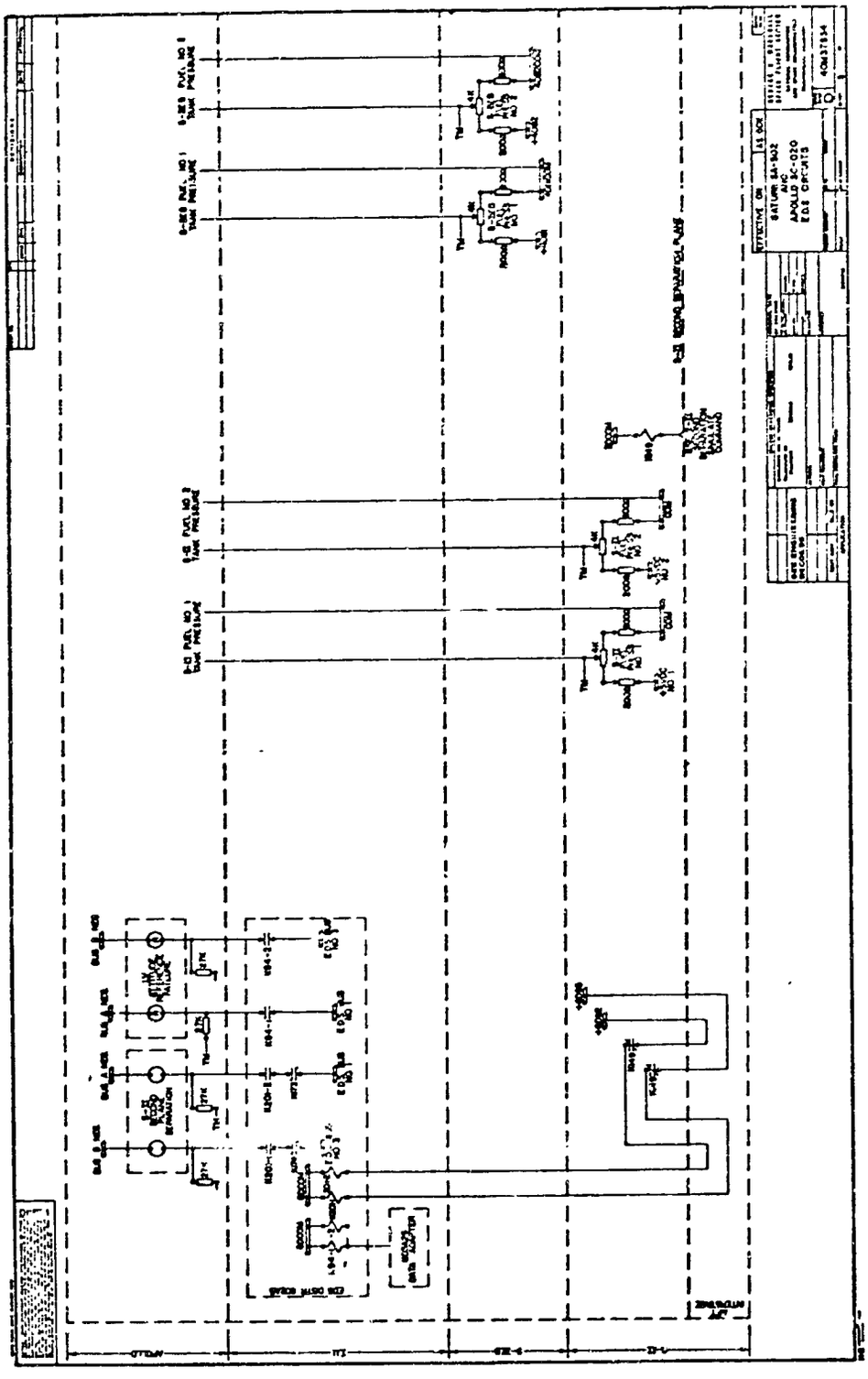
3. This circuit is not active on this mission and the function is inhibited.

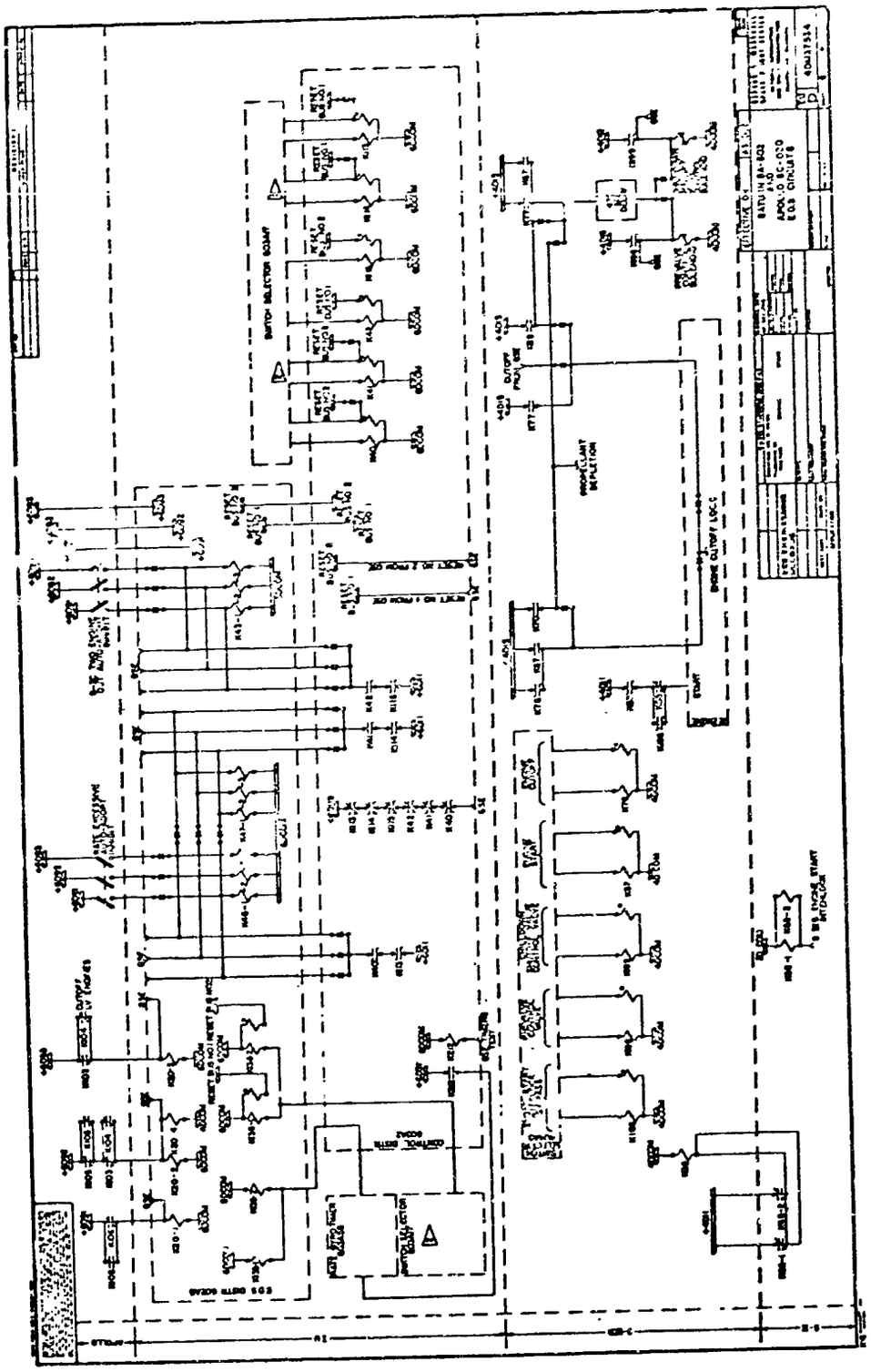




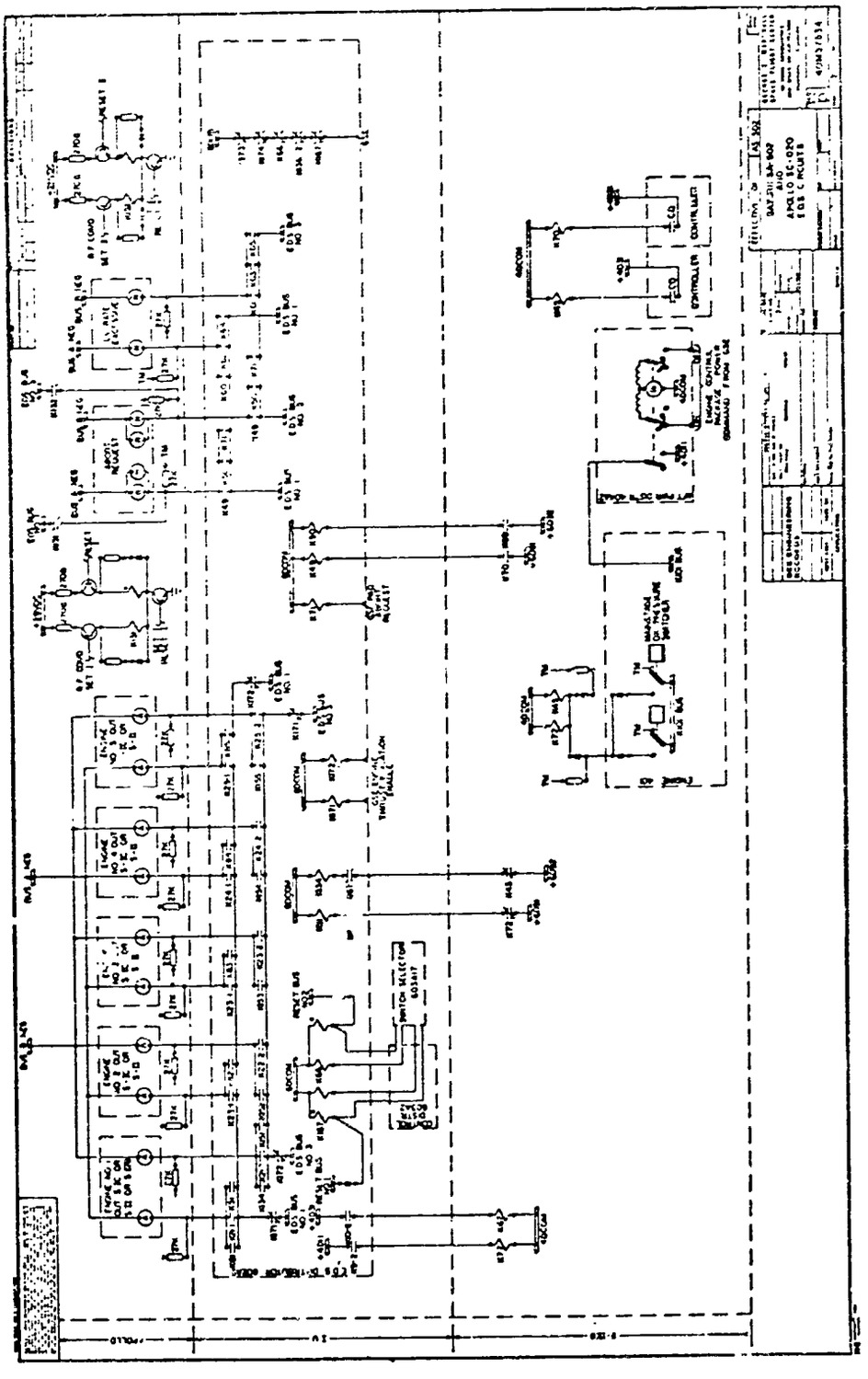


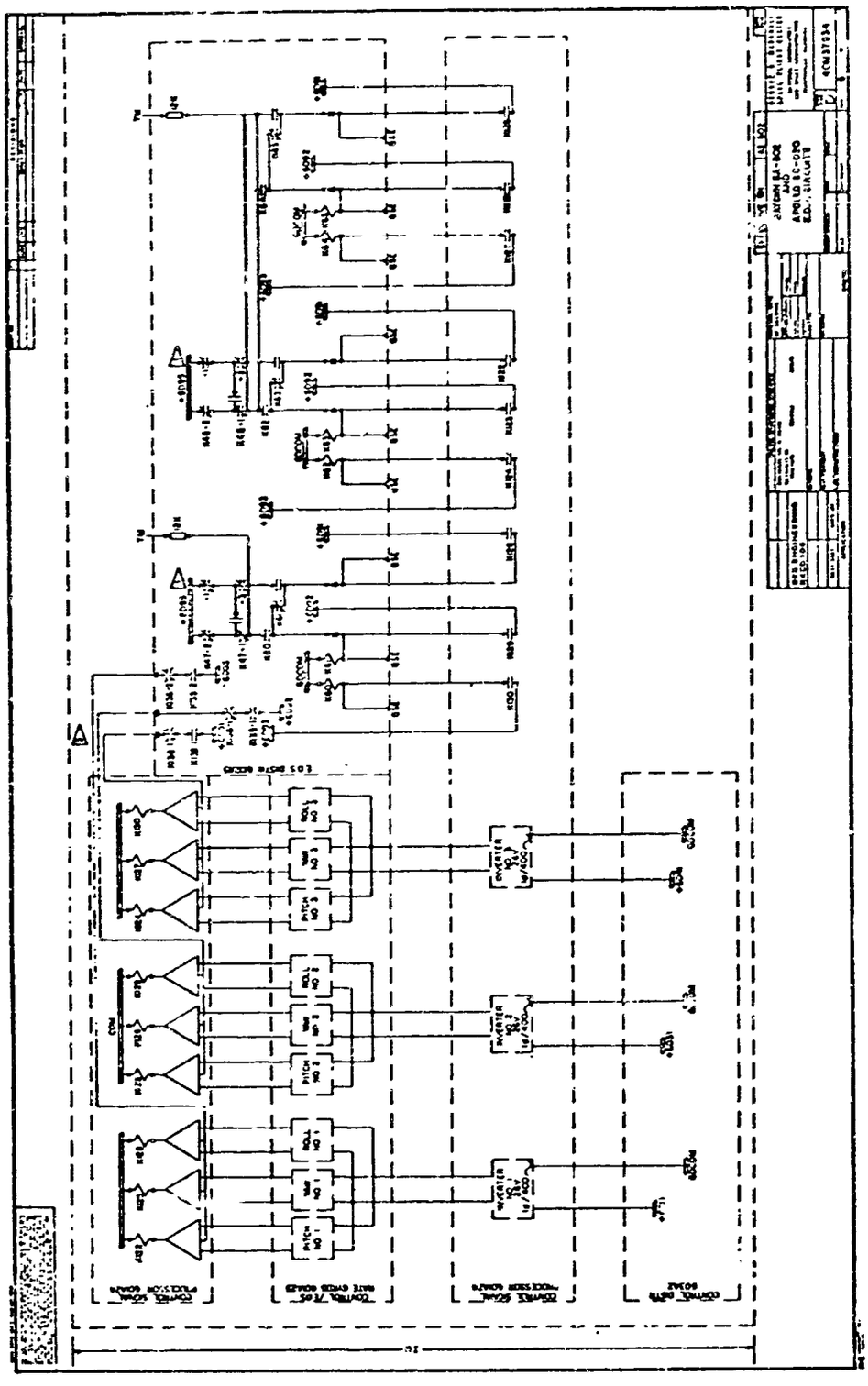


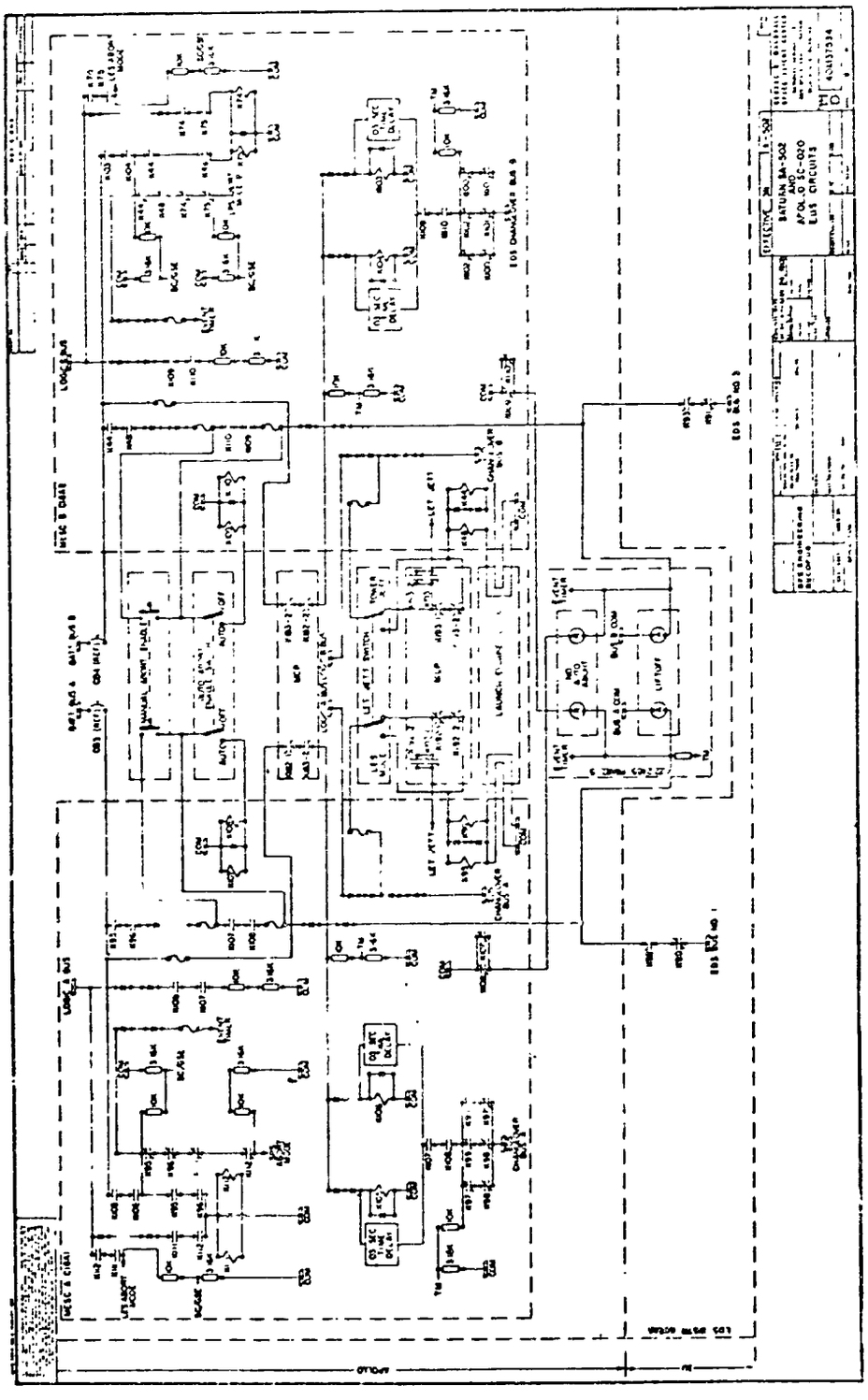


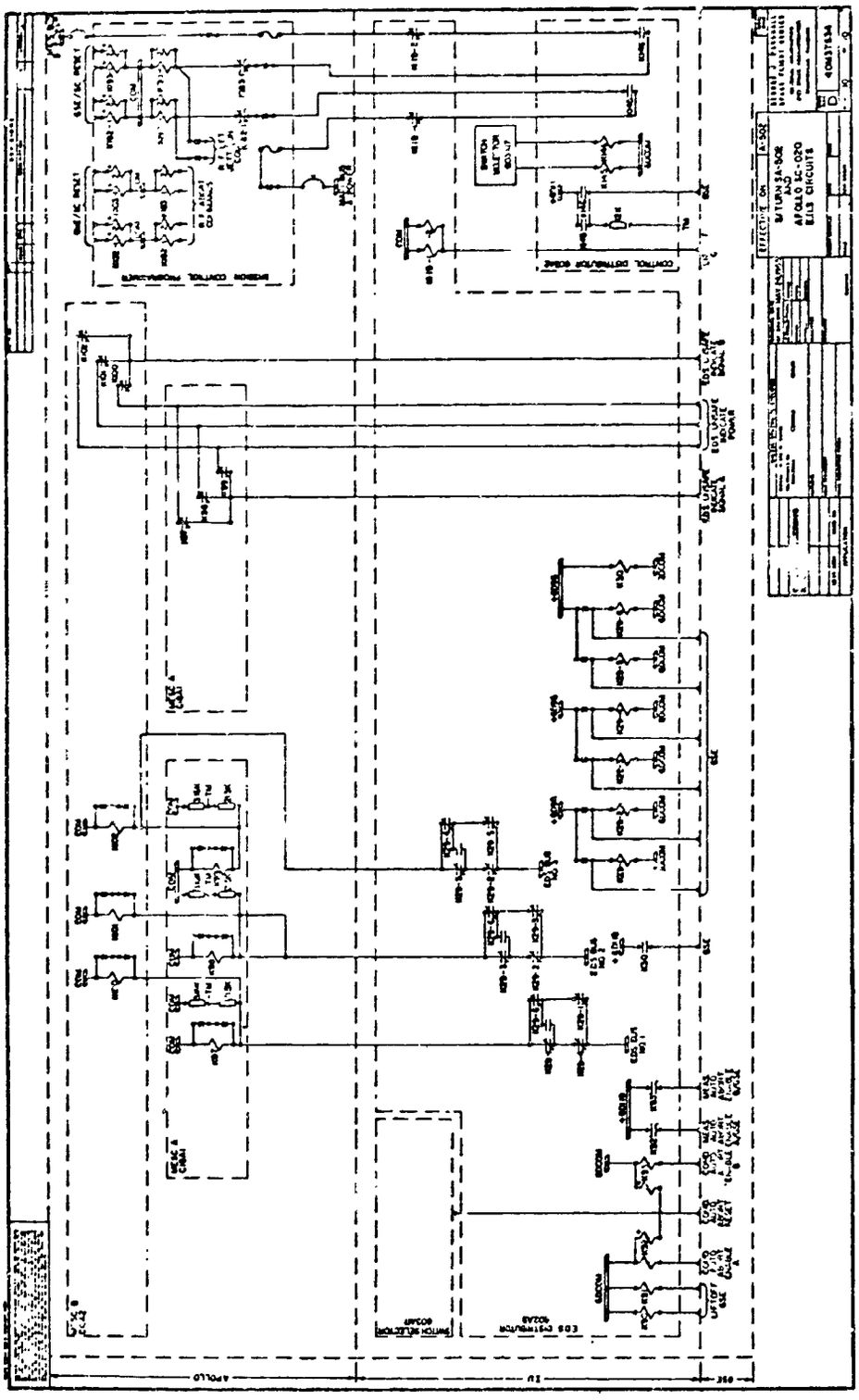


Added 15 October 1966









APPENDIX C*

GEORGE C. MARSHALL SPACE FLIGHT CENTER

INTERFACE CONTROL DOCUMENT
DESCRIPTION OF SATURN SA-503 AND APOLLO SC-102
EMERGENCY DETECTION SYSTEM

I. INTRODUCTION

A. The purpose of this document is to describe the Apollo-Saturn AS-503 Emergency Detection System (EDS) design. The design is a coordinated effort by the Crew Safety Panel members and represents inputs from several NASA Centers and is binding on all participating centers. The system defined in this document conforms to the "Design Criteria for Saturn-V On-Board Emergency Detection System, ICD (#13M50301).

B. This document defines interfaces between modules and stages in functional terms only. Detailed interface information is contained in other interface documents. The document drawing numbers and other pertinent information may be obtained from the "Inter-Center Interface Control Document Log."

C. This document does not reflect all connections from other systems into the EDS circuits.

II. ABBREVIATIONS

For use with this document the following abbreviations shall apply:

1.	ACE	Automatic Checkout Equipment
2.	AP	GSE Access Point Monitored by Apollo ACE
3.	AUTO	Automatic
4.	BATT	Battery
5.	BME	Bench Maintenance Equipment

APOLLO INTERFACE DOCUMENT

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* The ICD in this Appendix was dated February 1, 1966 and included Revision A dated June 21, 1966. Pages of the ICD that were modified for this Appendix do not retain the ICD drawing number.

6.	CB	Circuit Breaker
7.	CMD	Command
8.	CO	Cutoff
9.	COM	Common Return
10.	COMB	Combustion
11.	COMP	Component
12.	CTL	Control
13.	DC	Direct Current
14.	DDAS	Digital Data Aquisition System
15.	DEACT	Deactivate
16.	DISCH	Discharge
17.	DISTR	Distributor
18.	EDS	Emergency Detection System
19.	ENG	Engine
20.	FCM	Flight Combustion Monitor
21.	FTP	Fuel Tank Pressure
22.	FWD	Forward
23.	GPI	Gimbal Position Indicatio:
24.	GSE	Ground Support Equipment
25.	IND	Indication
26.	INSTR	Instrumentation
27.	IU	Instrument Unit
28.	JETT	Jettison
29.	LECO	Lox Engine Cutoff
30.	LES	Launch Escape System
31.	LET	Launch Escape Tower
32.	LH_2	Liquid Hydrogen
33.	LOX	Liquid Oxygen
34.	LV	Launch Vehicle
35.	MCP	Mission Control Programmer
36.	MEAS	Measurement
37.	MESC	Master Event Sequence Controller
38.	MS	Millisecond
39.	NC	Normally Closed
40.	NO	Normally Open
41.	No.	Number
42.	PRESS	Pressure
43.	PWR	Power
44.	RECIRC	Recirculation
45.	REQ	Request
46.	S	Switch
47.	S/C	Spacecraft
48.	SCS	Stabilization and Control System
49.	SEC	Second
50.	SEQ	Sequencer
51.	SPS	Service Propulsion System
52.	SUPV	Supervision
53.	TM	Telemetry
54.	USM	Apollo ACE Monitor at Service Module Umbilical

III ELECTRICAL SYMBOLS

(Refer to Section III in Appendix A)

IV INTERSTAGE SIGNALS

(Refer to Section IV in Appendix A)

V DESCRIPTION OF 28 VOLT BUSES

(Refer to Section V in Appendix A)

VI RELAY CROSS REFERENCE LIST
SATURN V
EDS Relay Functions

NOTE: Relay numbers shown are for reference only and do not correspond to actual hardware reference designations.

SATURN V
EDS RELAY FUNCTIONS

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K1	S-IC Engine No. 1 Thrust Voting Relay A					2	2	2
K2	S-IC Engine No. 2 Thrust Voting Relay A					2	2	2
K3	S-IC Engine No. 3 Thrust Voting Relay A					2	2	2
K4	S-IC Engine No. 4 Thrust Voting Relay A					2	2	2
K5	S-IC Engine No. 5 Thrust Voting Relay A					2	2	2
K9-1	EDS Manual/Auto Cutoff of LV Engines A				4		3	3
K9-2	EDS Manual/Auto Cutoff of LV Engines A						7	3
K10-1	EDS Manual/Auto Cutoff of LV Engines B				4		3	3
K10-2	EDS Manual/Auto Cutoff of LV Engines B						7	3
K11	S-IC Engine No. 1 Thrust Voting Relay B						2	2
K12	S-IC Engine No. Thrust Voting Relay B						2	2
K13	S-IC Engine No. 3 Thrust Voting Relay B						2	2
K14	S-IC Engine No. 4 Thrust Voting Relay B						2	2
K15	S-IC Engine No. 5 Thrust Voting Relay B						2	2
K19-1	EDS or Manual Cutoff of LV Engines Armed A				3		2	2

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K19-2	EDS or Manual Cutoff of LV Engines Armed B				3		2	2
K20-1	LV Engines Cutoff No. 1 from Apollo Spacecraft			3		3		10
K20-2	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	10
K20-3	LV Engines Cutoff No. 3 from Apollo Spacecraft			3		3		10
K20-4	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	10
K21-1	S-IC Engine No. 1 Thrust Monitor A						7	2
K21-2	S-IC Engine No. 1 Thrust Monitor B				7	2	2	2
K22-1	S-IC Engine No. 2 Thrust Monitor A				7	2	2	2
K22-2	S-IC Engine No. 2 Thrust Monitor B				7	2	2	2
K23-1	S-IC Engine No. 3 Thrust Monitor A				7	2	2	2
K23-2	S-IC Engine No. 3 Thrust Monitor B				7	2	2	2
K24-1	S-IC Engine No. 4 Thrust Monitor A				7	2	2	2
K24-2	S-IC Engine No. 4 Thrust Monitor B				7	2	2	2
K25-1	S-IC Engine No. 5 Thrust Monitor A				7	2	2	2
K25-2	S-IC Engine No. 5 Thrust Monitor B						7	2
K29-1	Auto-Abort 1A to Apollo Spacecraft			10		10	10	10
K29-2	Auto-Abort 1B to Apollo Spacecraft			10		10		10
K29-3	Auto-Abort 2A to Apollo Spacecraft			10		10	10	10
K29-4	Auto-Abort 2B to Apollo Spacecraft			10		10		10
K29-5	Auto-Abort 3A to Apollo Spacecraft			10		10	10	10

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K29-6	Auto-Abort 3B to Apollo Spacecraft			10		10		10
K30	6D95 Monitor to GSE						10	10
K31-1	S-IC Engine No. 1 Thrust Monitor No. 1			3		2	3	2
K31-2	S-IC Engine No. 1 Thrust Monitor No. 2	3		3		2	3	2
K31-3	S-IC Engine No. 1 Thrust Monitor No. 3	3		3		2	3	2
K32-1	S-IC Engine No. 2 Thrust Monitor No. 1					2		
K32-2	S-IC Engine No. 2 Thrust Monitor No. 2					2		
K32-3	S-IC Engine No. 2 Thrust Monitor No. 3					2		
K33-1	S-IC Engine No. 3 Thrust Monitor No. 1					2		
K33-2	S-IC Engine No. 3 Thrust Monitor No. 2					2		
K33-3	S-IC Engine No. 3 Thrust Monitor No. 3					2		
K34-1	S-IC Engine No. 4 Thrust Monitor No. 1					2		
K34-2	S-IC Engine No. 4 Thrust Monitor No. 2					2		
K34-3	S-IC Engine No. 4 Thrust Monitor No. 3					2		
K35-1	S-IC Engine No. 5 Thrust Monitor No. 1					2		
K35-2	S-IC Engine No. 5 Thrust Monitor No. 2					2		
K35-3	S-IC Engine No. 5 Thrust Monitor No. 3					2		
K39	EDS Bus Changeover B					1	1	1
K40	Excessive Rate Auto-Abort Inhibit (P, Y, & R)					6	6	6
K41	Excessive Rate Auto-Abort Inhibit (Roll)					6	6	6
K42	S-IC Two Engine Out Auto-Abort Inhibit					6	6	6

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K43-1	S-IC Two Engine Out Auto-Abort Inhibit No. 1			2		2		6
K43-2	S-IC Two Engine Out Auto-Abort Inhibit No. 2			2		2		6
K43-3	S-IC Two Engine Out Auto-Abort Inhibit No. 3					2		6
K44	LET Jettisioned B1				5	9	9	9
K45	S-IVB Engine Thrust Monitor B					7		7
K46-1	Excessive Rate Auto-Abort Inhibit (P & Y) No. 1			8		8	8	6
K46-2	Excessive Rate Auto-Abort Inhibit (P & Y) No. 2					8		6
K46-3	Excessive Rate Auto-Abort Inhibit (P & Y) No. 3					3		6
K47-1	Excessive Rate Auto-Abort Inhibit (Roll) No. 1			8		8	8	6
K47-2	Excessive Rate Auto-Abort Inhibit (Roll) No. 2					8		6
K47-3	Excessive Rate Auto-Abort Inhibit (Roll) No. 3					8		6
K48	LET Jettisoned B2				5	9	9	9
K49	Range Safety Destruct Armed A from S-IVB				7		7	7
K50	Range Safety Destruct Armed B from S-IVB				7		7	7
K51	S-IVB Thrust Monitor A Indicator						7	7
K53	EDS Manual/Auto Cutoff A of S-IC Engines				3		3	3
K54-1	EDS Manual/Auto Cutoff B of S-IC Engines						3	3
K54-2	EDS Manual/Auto Cutoff B of S-IC Engines				3		3	3
K55	S-IC Engines Cutoff Enable						3	3
K56	S-IC Engines Cutoff Enable						3	3
K57	S-IVB Engine Start Command						7	6
K58	S-IVB Engine Prevent Start					7		6
K59	S-IC All Engine OK A					2		2

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K60	Excessive Roll Rate Voting Relay A				8		7	8
K61	Excessive Roll Rate Voting Relay B				8	8	7	8
K62	Excessive Pitch Rate Voting Relay A				8		7	8
K63	Excessive Pitch Rate Voting Relay B				8	8	7	8
K64	Excessive Yaw Rate Voting Relay A				8		7	8
K65	Excessive Yaw Rate Voting Relay B				8	8	7	8
K66	EDS Arming of S-IVB Engine Thrust Indication A					7	7	7
K68-1	S-II/S-IVB Separation Simulate					6		6
K68-2	S-II/S-IVB Separation Simulate					6		6
K69	Range Safety S-IVB Destruct Arm B						7	7
K70	Range Safety S-IVB Destruct Arm A						7	7
K71	Pad Abort Request				7		7	7
K72	S-IVB Thrust Monitor A					7		7
K73	EDS Bus Changeover A					1	1	1
K74	LES Abort Lock-up A1				9	9	9	9
K75	LES Abort Lock-up A2				9	9	9	9
K76	Normal S-IVB Engine Cutoff						7	6
K78	Cutoff S-IC Inboard Engine						3	3
K79	Cutoff S-IC Outboard Engine						3	3
K80	S-II All Engines Normal Cutoff						4	4
K81	S-II Engine No. 1 Thrust Monitor A						7	4
K82	S-II Engine No. 2 Thrust Monitor A						7	
K83	S-II Engine No. 3 Thrust Monitor A						7	
K84	S-II Engine No. 4 Thrust Monitor A						7	

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K85	S-II Engine No. 5 Thrust Monitor A						7	
K90	EDS Liftoff Inhibit A					9		10
K91	EDS Liftoff Inhibit B					9		10
K92	EDS Liftoff Enable A				10		9	10
K93	EDS Liftoff Enable B				10		9	10
K94-1	LV Attitude Reference Fail A				5		5	5
K94-2	LV Attitude Reference Fail B						5	5
K95	LET Jettisoned A1				9	9	9	9
K96	LET Jettisoned A2				9	9	9	9
K97	EDS Abort Voting Logic Input A1	10		9		9		10
K98	EDS Abort Voting Logic Input A2	10		9		9		10
K99	EDS Abort Voting Logic Input A3	10		9		9		10
K100	EDS Abort Voting Logic Input B1	10		9		9		10
K101	EDS Abort Voting Logic Input B2	10		9		9		10
K102	EDS Abort Voting Logic Input B3	10		9		9		10
K103	Abort B1			10		10	9	9
K104	Abort B2			10		10	9	9
K105	Abort A1			10		10	9	9
K106	Abort A2			10		10	9	9
K107	Auto-Abort System Enable A1		9		9	9	9	9
K108	Auto-Abort System Enable A2		9		9	9	9	9
K109	Auto-Abort System Enable B1		9		9	9	9	9
K110	Auto-Abort System Enable B2		9		9	9	9	9
K111	LES Abort Lock-up B1				9	9	9	9
K112	LES Abort Lock-up B2				9	9	9	9
K113	Excessive Rate Auto-Abort Inhibit (P, Y, & R)					6	6	6
K114	Excessive Rate Auto-Abort Inhibit (Roll)					6	6	6

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K115	S-IC Two Engine Out Auto-Abort Inhibit Enable					6	6	6
K116	+6D91 Bus GSE Disable					1		1
K117	+6D92 Bus GSE Disable					1		1
K118	+6D93 Bus GSE Disable					1		1
K121-1	S-II Engine No. 1 Thrust Monitor A (Type 1 of 5)			4		4		4
K121-2	S-II Engine No. 1 Thrust Monitor B (Type 1 of 5)					4		4
K122	Excessive Pitch Rate Output No. 1						8	8
K123	Excessive Pitch Relay Output No. 2						8	8
K124	Excessive Pitch Rate Output No. 3						8	8
K125	Excessive Yaw Rate Output No. 1						8	8
K126	Excessive Yaw Rate Output No. 2						8	8
K127	Excessive Yaw Rate Output No. 3						8	8
K128	Excessive Roll Rate Output No. 1						8	8
K129	Excessive Roll Rate Output No. 2						8	8
K130	Excessive Roll Rate Output No. 3						8	8
K131	RF Link Abort Request A						7	7
K132	RF Link Abort Request B						7	7
K134	S-IVB Thrust OK Monitor B Indication						7	7
K135-1	Rate Gyro High Rate On A1				8		8	6
K135-2	Rate Gyro High Rate On A2						8	6
K136-1	Rate Gyro High Rate On B1			8		8		6
K136-2	Rate Gyro High Rate On B2			7		8		6
K137	Logic A Bus Arm A						1	1
K138	Logic A Bus Arm B						1	1
K139	Logic B Bus Arm A						1	1
K140	Logic B Bus Arm B						1	1

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K163	S-II Start Phase Limiter Cutoff Arm						4	4
K166	Engine Start Interlock By-pass						7	6
K167	EDS Arming of S-IVB Engine Thrust Indication B					7		7
K171	GSE Engine Thrust Indication Enable A			7		7		7
K172	GSE Engine Thrust Indication Enable B			7		7		7
K173	EDS Arming Of S-II Thrust Indication A				5	7	4	4
K174	EDS Arming of S-II Thrust Indication B				5	7	4	4
K198	S-IVB Prevalve Control Command						7	6
K199	S-IVB Chilldown Shutoff Command						7	6
K201-1	S-II Second Plane Separation A					5		5
K201-2	S-II Second Plane Separation B					5		5
K202	S-IC Range Safety Engines Cutoff A				3		3	3
K203-1	S-IC Range Safety Engines Cutoff B1				3		3	3
K203-2	S-IC Range Safety Engines Cutoff B2						3	3
K208	S-II Engine No. 1 Cutoff					4	4	4
K209	S-II Engine No. 1 Lox and LH_2 Prevalves Control				4		4	4
K210	S-II Prevalve Lockout Command from GSE					4	4	4
K212	Timers Test				2		6	6
K214-1	Normal S-II Engines Cutoff B1						4	4
K214-2	Normal S-II Engines Cutoff B2						4	4
K215-1	Normal S-II Engines Cutoff A1						4	4
K215-2	Normal S-II Engines Cutoff A2						4	4
K216	S-II All Engines Start Command						4	4

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Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K217	S-II Engines Prevent Start					4		4
K218	S-II Engines Prevent Start By-pass Command					4		4
K219	S-IC All Engine OK B					2		2

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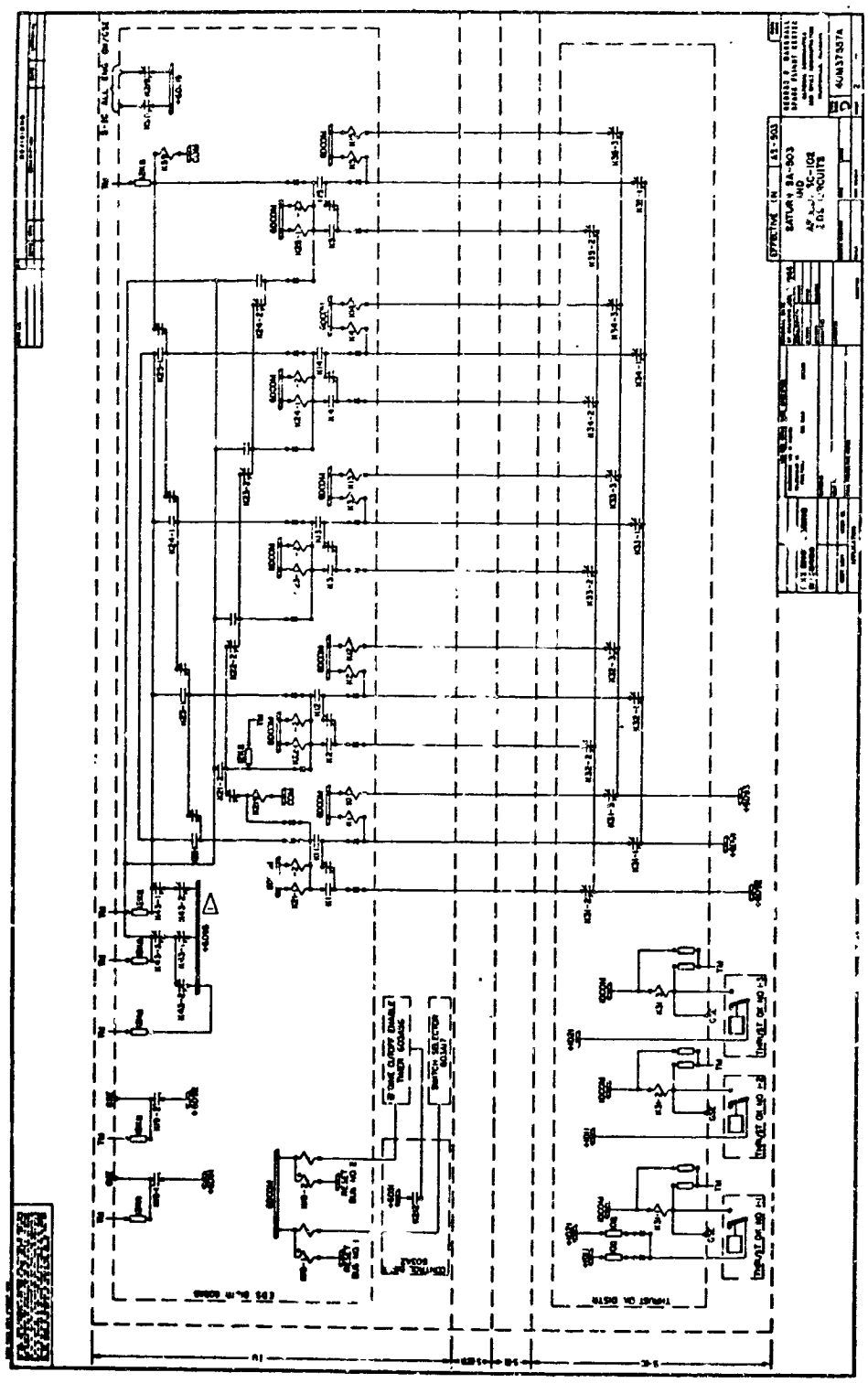
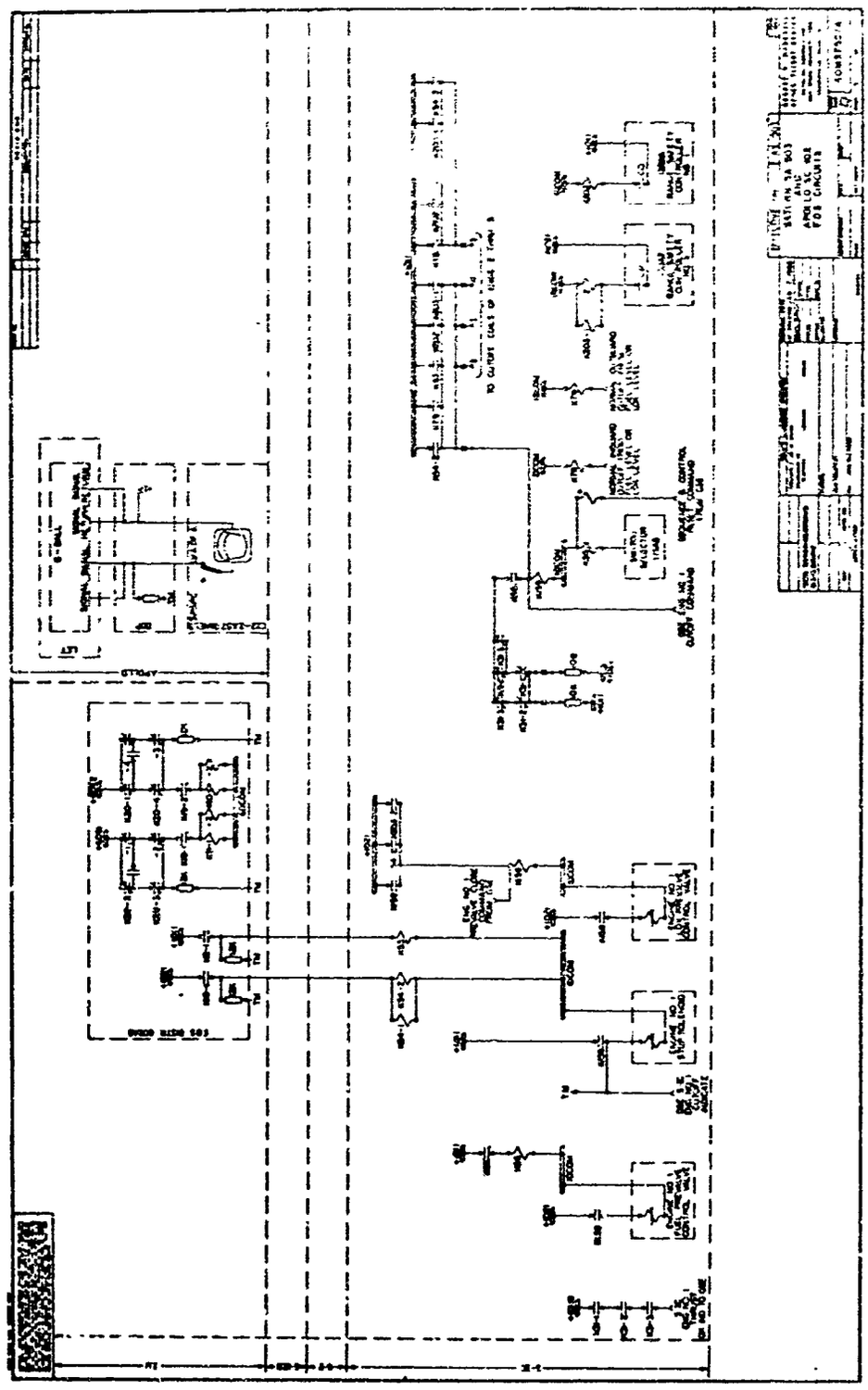
DRAWING NOTES:

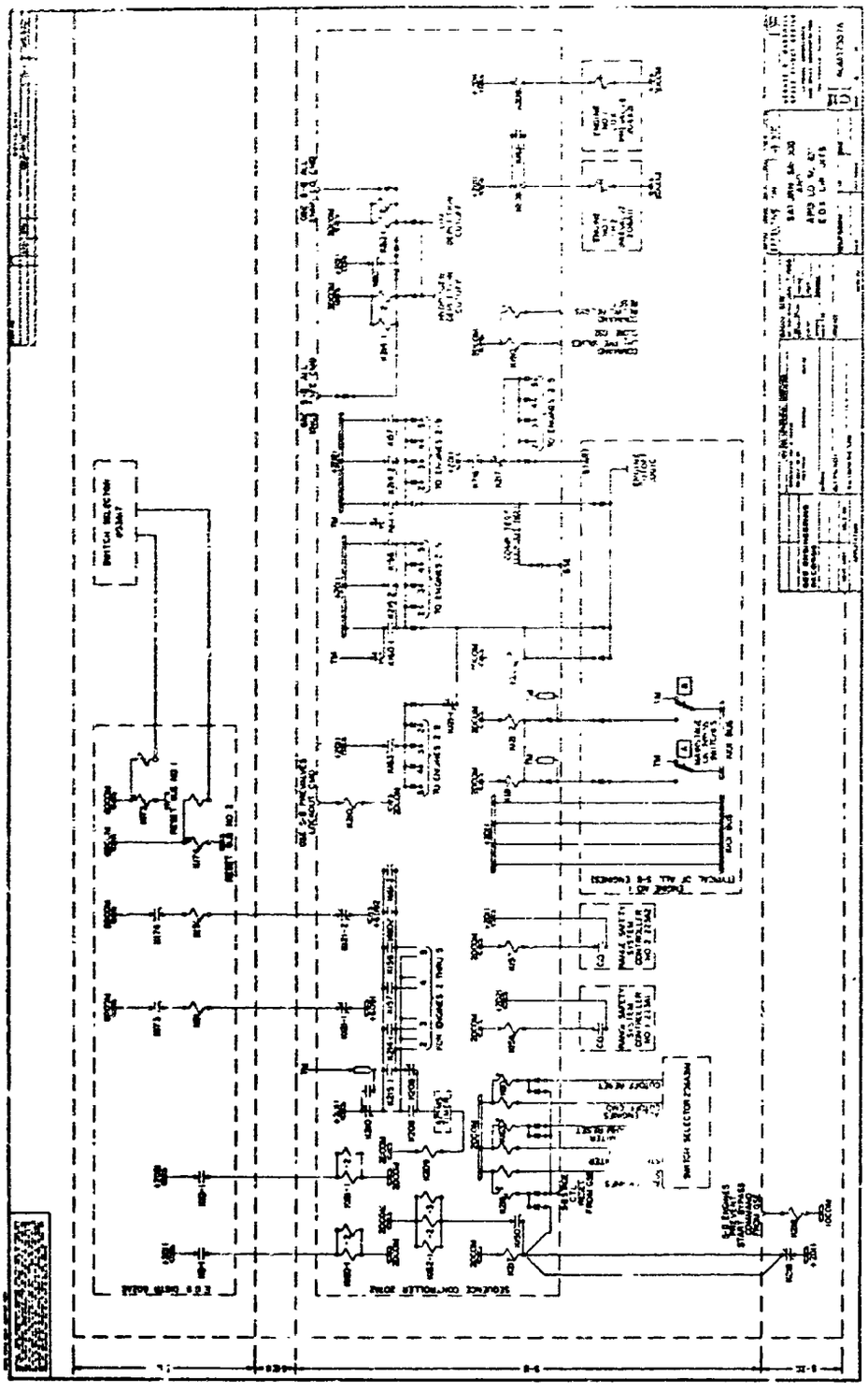
1. The Auto-Abort bus, +6D95, can be energized from the excessive rate circuit as well as the two engine out circuit.

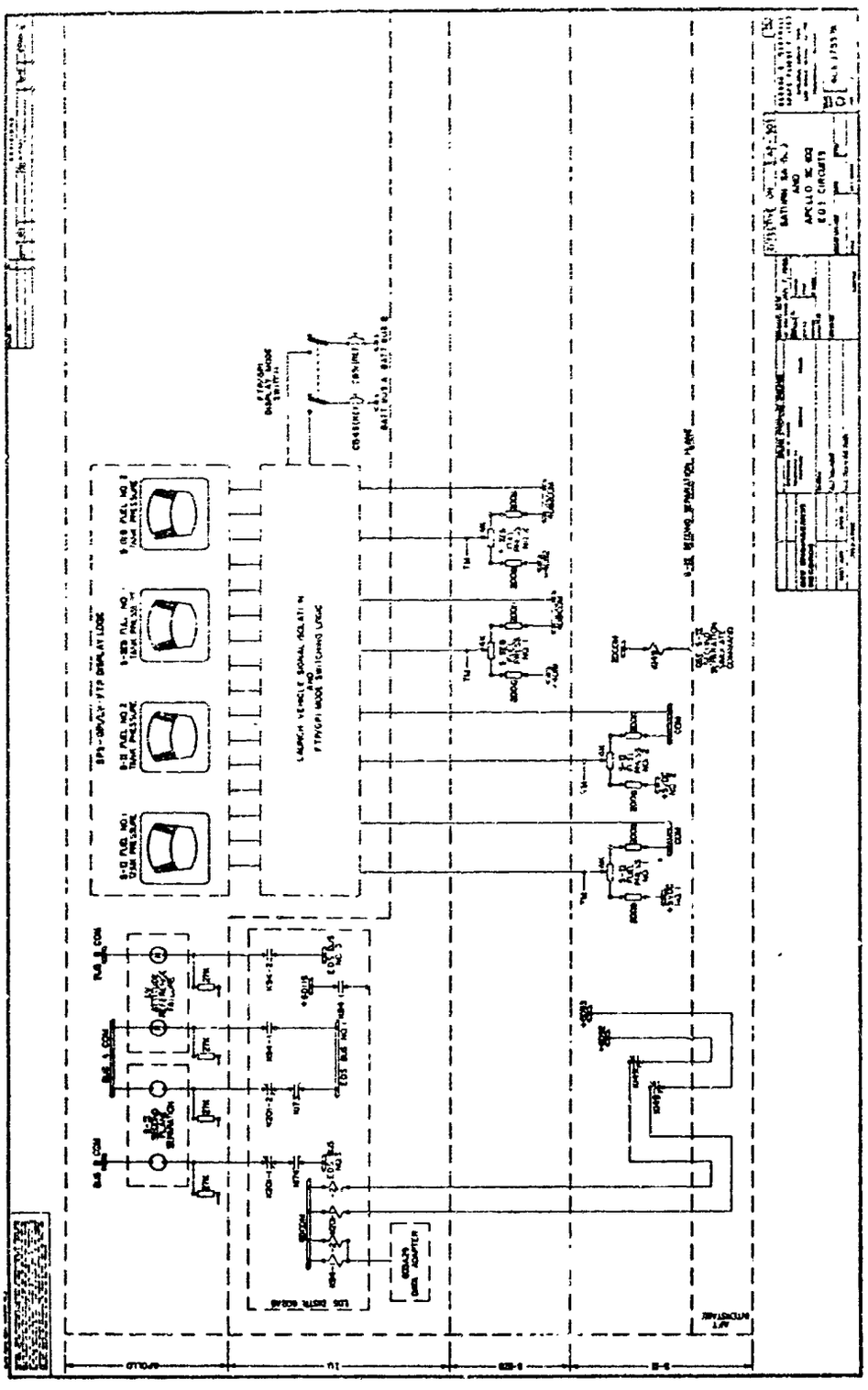
2. This function is not programmed on the switch selector for this mission.

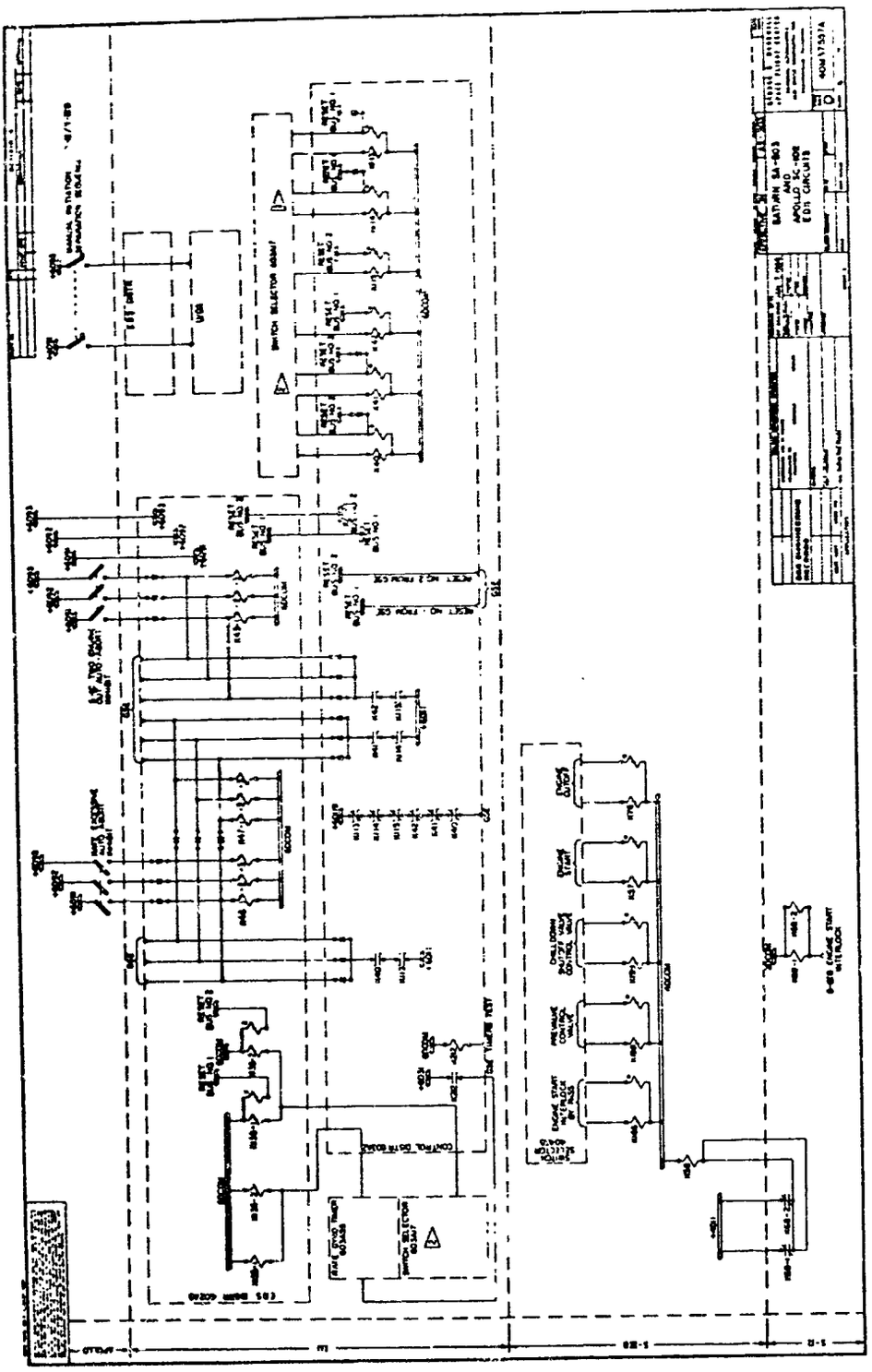
3. This circuit is not active on this mission and the function is inhibited.

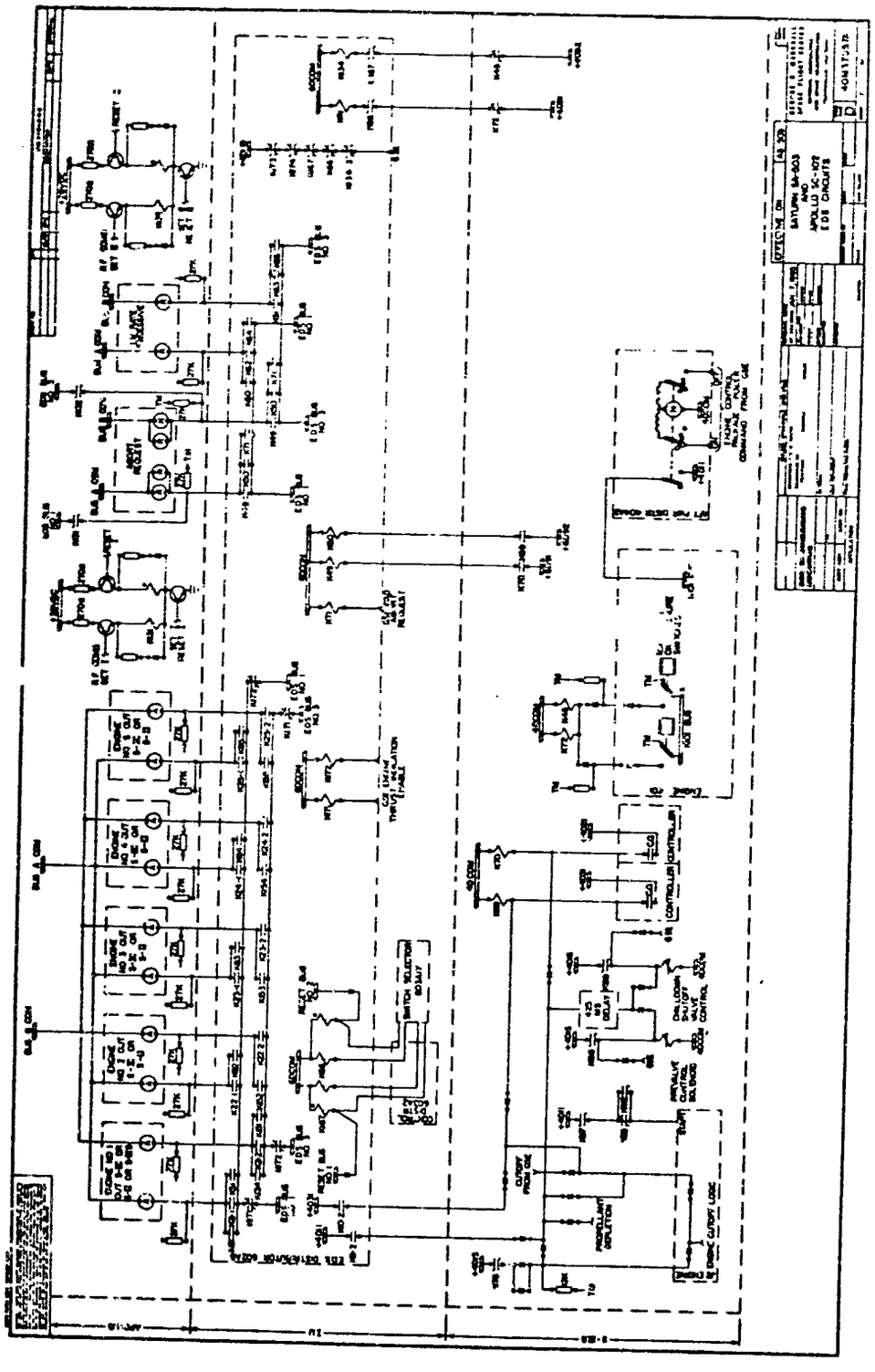


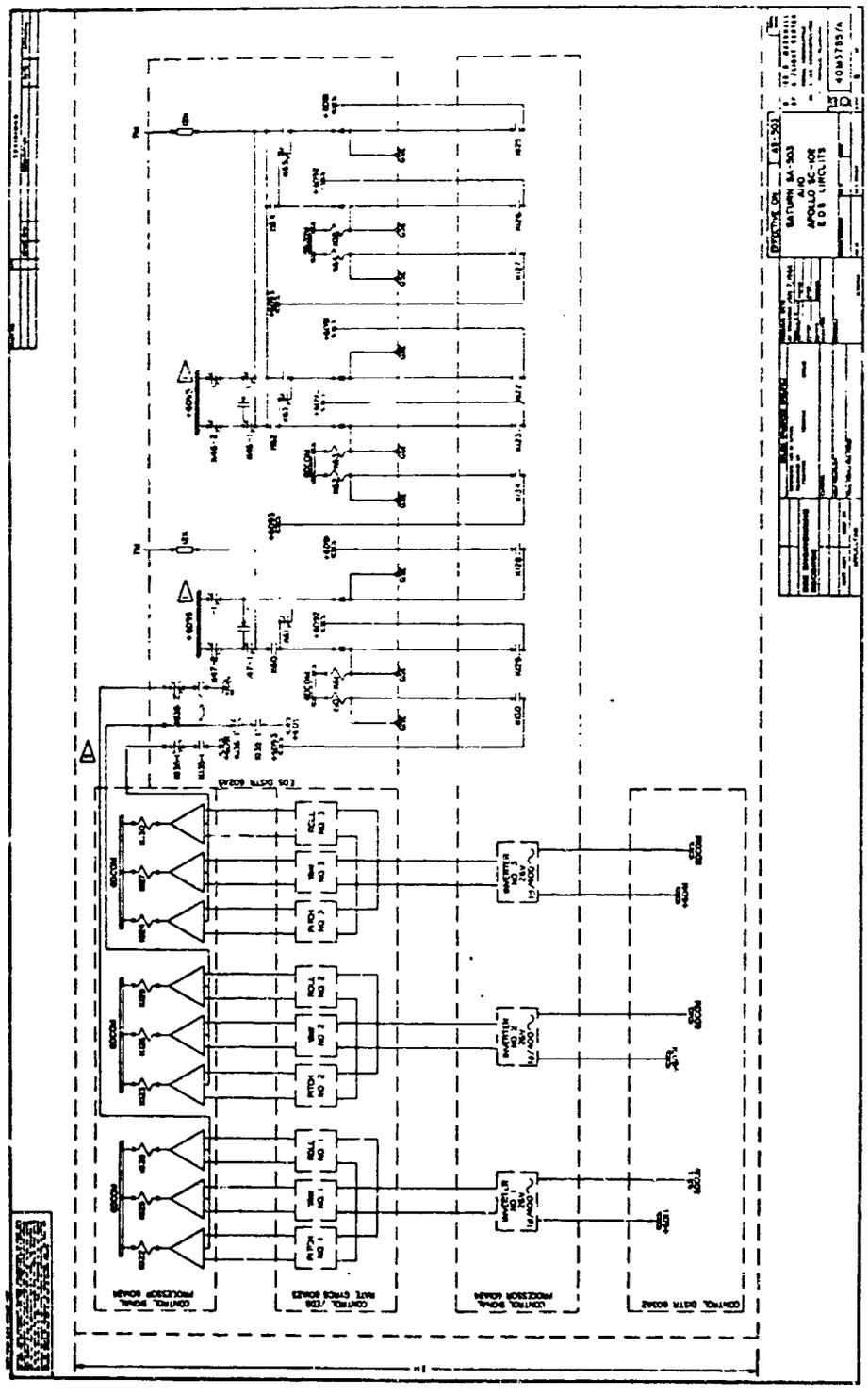


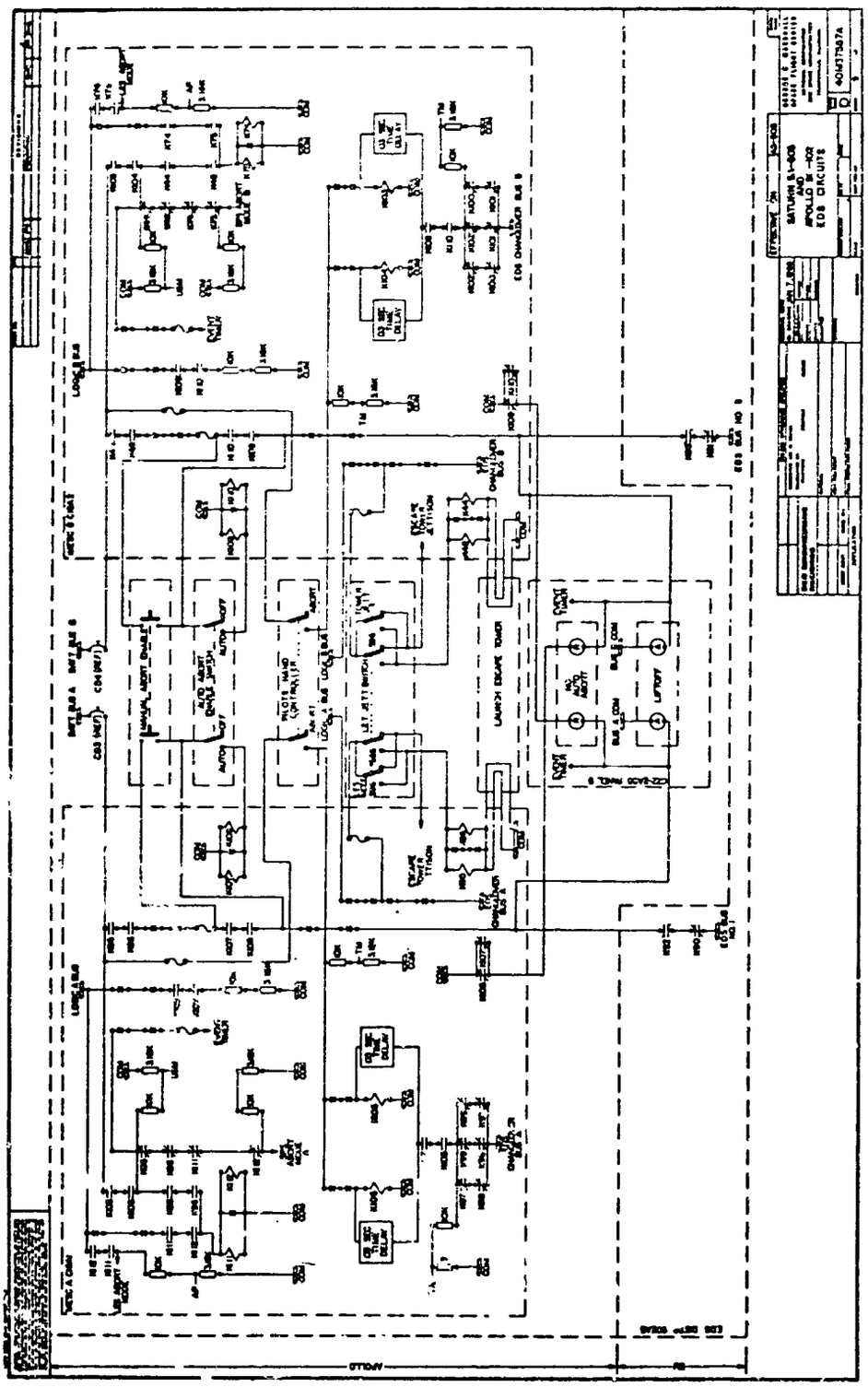


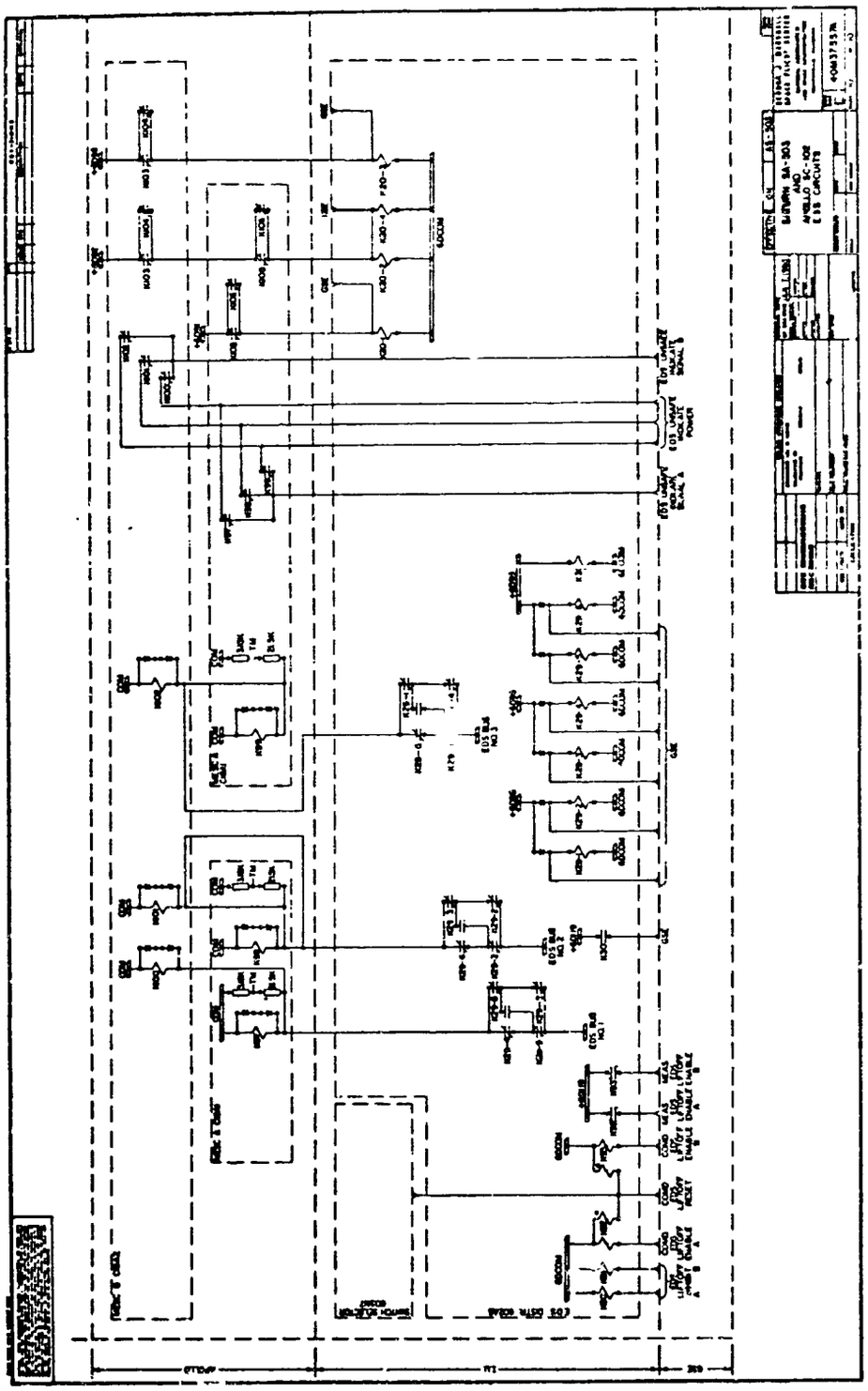












APPENDIX D*

GEORGE C. MARSHALL SPACE FLIGHT CENTER

INTERFACE CONTROL DOCUMENT
DESCRIPTION OF SATURN SA-504 AND APOLLO SC-1[illegible]
EMERGENCY DETECTION SYSTEM

I. INTRODUCTION

A. The purpose of this document is to describe the Apollo-Saturn AS-504 Emergency Detection System (EDS) design. The design is a coordinated effort by the Crew Safety Panel members and represents technical inputs from several NASA Centers and is binding on all participating centers. The system defined in this document conforms to the "Design Criteria for Saturn-V On-Board Emergency Detection System, ICD (#13M65001)."

B. This document defines interfaces between modules and stages in functional terms only. Detailed interface information is contained in other interface documents. The document drawing numbers and other pertinent information may be obtained from the "Inter-Center Interface Control Document Log."

C. The document does not reflect all connections from other systems into the EDS circuits.

II. ABBREVIATIONS

For use with this document the following abbreviations shall apply:

1.	ACE	Automatic Checkout Equipment
2.	AP	[illegible]SE Access Point Monitored by Apollo ACE
3.	AUTO	Automatic
4.	BATT	Battery
5.	BME	Bench Maintenance Equipment

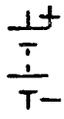
APOLLO INTERFACE DOCUMENT

* The ICD in this Appendix was dated Feb. 23, 1966, and contained revision A dated Sept. 15, 1966.

6.	CB	Circuit Breaker
7.	CMD	Command
8.	CO	Cutoff
9.	COM	Common Return
10.	COMB	Combustion
11.	COMP	Component
12.	CTL	Control
13.	DC	Direct Current
14.	DDAS	Digital Data Acquisition System
15.	DEACT	Deactivate
16.	DISCH	Discharge
17.	DISTR	Distributor
18.	EDS	Emergency Detection System
19.	ENG	Engine
20.	FCM	Flight Combustion Monitor
21.	FTP	Fuel Tank Pressure
22.	FWD	Forward
23.	GPI	Gimbal Position Indication
24.	GSE	Ground Support Equipment
25.	IND	Indication
26.	INSTR	Instrumentation
27.	IU	Instrument Unit
28.	JETT	Jettison
29.	LECO	LOX Engine Cutoff
30.	LES	Launch Escape System
31.	LET	Launch Escape Tower
32.	LH_2	Liquid Hydrogen
33.	LOX	Liquid Oxygen
34.	LV	Launch Vehicle
35.	MCP	Mission Control Programmer
36.	MEAS	Measurement
37.	MESC	Master Event Sequence Controller
38.	MS	Millisecond
39.	NC	Normally Closed
40.	NO	Normally Open
41.	No.	Number
42.	PRESS	Pressure
43.	PWR	Power
44.	RECIRC	Recirculation
45.	REQ	Request
46.	S	Switch
47.	SC	Spacecraft
48.	SCS	Stabilization and Control System
49.	SEC	Second
50.	SEQ	Sequencer
51.	SPS	Service Propulsion System
52.	SUPV	Supervision
53.	TM	Telemetry
54.	USM	Apollo ACE Monitor at Service Module Umbilical

III. ELECTRICAL SYMBOLS

The electrical symbols used in this document are listed below.



Battery

Elect. Magnetic Latch Relay Coil

Diode or Rectifier

Electrical Relay Coil

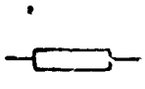
Magnetic Latch
Normally Closed

Magnetic Latch
Normally Open

Solenoid

Normally Closed
Electrical Relay Contacts

Normally Open
Electrical Relay
Contacts



Resistor

Fuse

Amplifier

APOLLO INTERFACE DOCUMENT

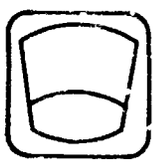
Transistor - NPN

Transistor -PNP

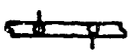
Indicating Lamp

Explosive Squib

Meter
(Biased)



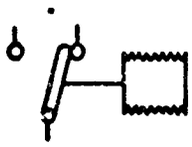
Meter



Bus

Terminal
Solder or Crimped

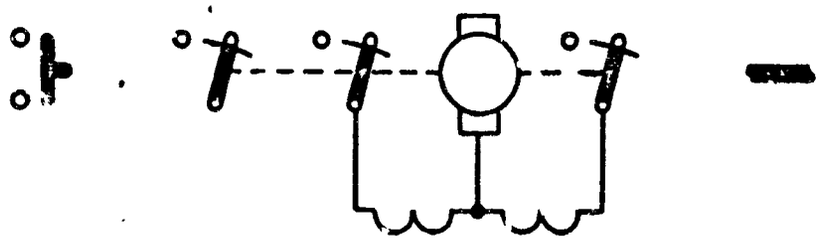
Single Throw Switch



Pressure Switch
Transfer with Increase
in Pressure

Circuit Breaker

Double Throw Switch



Push Button
Switch/Maintained

Motor Switch

Bus/First Energized

APOLLO INTERFACE DOCUMENT

IV. INTERSTAGE SIGNALS

The method used in transmitting signals between stages will be as follows: If stage "A" requires a signal from stage "B" it will furnish stage "B" with a plus 28 volts, and stage "B" will switch the plus 28 volts and return the switched signal to stage "A". (See figure 1.) The plus 28 volts for signal transmission need only be furnished one time for a set of signals between stage This method of transmitting signals allows the d.c. power of each stage to be completely independent and eliminates the problems of current transfer in the negative side of the d.c. power systems.

V. DESCRIPTION OF 28 VOLT BUSES

+1D10 The +1D10 bus is supplied directly from S-IC Battery Number One (115A10).

+1D11 The +1D11 bus is supplied from the +1D111 bus before power transfer or the +1D10 bus after power transfer.

+1D20 The +1D20 bus is supplied directly from S-IC Battery Number Two (115A20).

+1D21 The +1D21 bus is supplied from the +1D211 bus before power transfer or the +1D20 bus after power transfer.

+1D111 The +1D111 bus is supplied from the GSE networks and supplies the +1D11 bus during vehicle checkout and prelaunch sequence prior to power transfer.

+1D119 The +1D119 bus is supplied from the +1D119 supply in the GSE.

+1D211 The +1D211 bus is supplied from the GSE networks and supplies the +1D21 bus during vehicle checkout and prelaunch sequence prior to power transfer.

+2D11 The +2D11 bus is supplied from any of the following:

(a) GSE Regulated +28 VDC Main Power Supply before power transfer.

(b) S-II Main Battery 207A1A1 after power transfer.

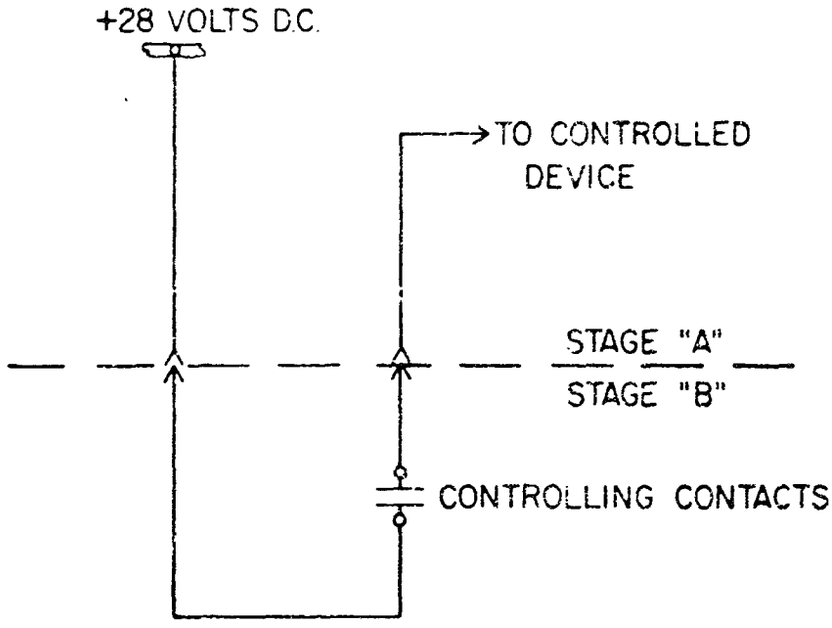


Figure 1. Interstage Signals

+2D21 The +2D21 bus is supplied from any of the following:
- (a) GSE Regulated +28 VDC Instrumentation Power Supply before power transfer.
- (b) S-II Instrumentation Battery 207A1A2 after power transfer.

+4D11 The +4D11 bus is supplied from the +4D111 bus before power transfer or the +4D10 bus after power transfer.

+4D15 The +4D15 bus is supplied from the +4D11 bus after the S-IVB receives the "Sequencer Power ON Command" from GSE.

+4D31 The +4D31 bus is supplied from the +4D131 bus before power transfer or the +4D30 bus after power transfer.

+6D10 The +6D10 bus is supplied directly from the IU Battery 601A7.

+6D11 The +6D11 bus is supplied from the +6D111 bus before power transfer or the +6D10 bus after power transfer.

Logic Bus B	Supplied from Battery Bus B through a circuit breaker and logic bus arm relay. This bus, which is used to activate EDS circuitry in the MESC B, may be armed or safed manually with either of the two redundant logic bus arm switches which operate the logic bus arm relay.
Reset Bus No. 1	Supplied from the GSE networks and is used to reset critical EDS magnetic latch relays prior to launch. It may also be used during vehicle checkout to return these relays to their normal position.
Reset Bus No. 2	Supplied from the GSE networks and is used to reset critical EDS magnetic latch relays prior to launch. It may also be used during vehicle checkout to return these relays to their normal position.

VI. RELAY CROSS REFERENCE LIST

SATURN V
EDS RELAY FUNCTIONS

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K1	S-IC Engine No. 1 Thrust Voting Relay A					2	2	2
K2	S-IC Engine No. 2 Thrust Voting Relay A					2	2	2
K3	S-IC Engine No. 3 Thrust Voting Relay A					2	2	2
K4	S-IC Engine No. 4 Thrust Voting Relay A					2	2	2
K5	S-IC Engine No. 5 Thrust Voting Relay A					2	2	2
K9-1	EDS Manual/Auto Cutoff of LV Engines A				4		3	3
K9-2	EDS Manual/Auto Cutoff of LV Engines A						7	3
K10-1	EDS Manual/Auto Cutoff of LV Engines B				4		3	3

+6D30	The +6D30 bus is supplied directly from the IU Battery 601A9.
+6D31	The +6D31 bus is supplied from the +6D211 bus before power transfer or the +6D30 bus after power transfer.
+6D40	The +6D40 bus is supplied directly from the IU Battery 601A10.
+6D41	The +6D41 bus is supplied from the +6D211 bus before power transfer or the +6D40 bus after power transfer.
+6D91	The +6D91 bus is supplied from the +6D11 bus and is one of three EDS buses used in the IU for EDS circuitry.
+6D92	The +6D92 bus is supplied from the +6D31 bus and is one of three buses used in the IU for EDS circuitry.
+6D93	The +6D93 bus is supplied from the +6D41 bus and is one of three buses used in the IU for EDS circuitry.
+6D119	The +6D119 bus is supplied to the IU from GSE.
Battery Bus A	Battery Bus A is supplied from the Apollo Entry Battery A through a circuit breaker.
Battery Bus B	Battery Bus B is supplied from the Apollo Entry Battery B through a circuit breaker.
EDS Bus No. 1	The EDS Bus No. 1 is supplied from Battery Bus A through a circuit breaker and the EDS power switch.
EDS Bus No. 2	The EDS Bus No. 2 is supplied from Battery C through a circuit breaker and the EDS power switch.
EDS Bus No. 3	The EDS Bus No. 3 is supplied from the Battery Bus B through a circuit breaker and the EDS power switch.
EDS Changeover Bus A	The EDS Changeover Bus A is energized from EDS Bus No. 1 except when EDS Bus No. 1 fails (becomes deenergized) it automatically switches over to EDS Bus No. 2
EDS Changeover Bus B	The EDS Changeover Bus B is energized from EDS Bus No. 3 except when EDS Bus No. 3 fails (becomes deenergized) it automatically switches over to EDS Bus No. 2
Logic Bus A	Supplied from Battery Bus A through a circuit breaker and logic bus arm relay. This bus, which is used to activate EDS circuitry in the MESC A, may be armed or safed manually with either of the two redundant logic bus arm switches which operate the logic bus arm relay.

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K10-2	EDS Manual/Auto Cutoff of LV Engines B						7	3
K11	S-IC Engine No. 1 Thrust Voting Relay B						2	2
K12	S-IC Engine No. 2 Thrust Voting Relay B						2	2
K13	S-IC Engine No. 3 Thrust Voting Relay B						2	2
K14	S-IC Engine No. 4 Thrust Voting Relay B						2	2
K15	S-IC Engine No. 5 Thrust Voting Relay B						2	2
K19-1	EDS or Manual Cutoff of LV Engines Armed A				3		2	2
K19-2	EDS or Manual Cutoff of LV Engines Armed B				3		2	2
K20-1	LV Engines Cutoff No. 1 from Apollo Spacecraft			3		3		10
K20-2	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	10
K20-3	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3		10
K20-4	LV Engines Cutoff No. 2 from Apollo Spacecraft			3		3	3	10
K21-1	S-IC Engine No. 1 Thrust Monitor A						7	2
K21-2	S-IC Engine No. 1 Thrust Monitor B				7	2	2	2
K22-1	S-IC Engine No. 2 Thrust Monitor A				7	2	2	2
K22-2	S-IC Engine No. 2 Thrust Monitor B				7	2	2	2

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K23-1	S-IC Engine No. 3 Thrust Monitor A				7	2	2	2
K23-2	S-IC Engine No. 3 Thrust Monitor B				7	2	2	2
K24-1	S-IC Engine No. 4 Thrust Monitor A				7	2	2	2
K24-2	S-IC Engine No. 4 Thrust Monitor B				7	2	2	2
K25-1	S-IC Engine No. 5 Thrust Monitor A				7	2	2	2
K25-2	S-IC Engine No. 5 Thrust Monitor B						7	2
K29-1	Auto-Abort 1A to Apollo Spacecraft			10		10	10	10
K29-2	Auto-Abort 1B to Apollo Spacecraft			10		10		10
K29-3	Auto-Abort 2A to Apollo Spacecraft			10		10	10	10
K29-4	Auto-Abort 2B to Apollo Spacecraft			10		10		10
K29-5	Auto-Abort 3A to Apollo Spacecraft			10		10	10	10
K29-6	Auto-Abort 3B to Apollo Spacecraft			10		10		10
K30	+6D95 Monitor to GSE						10	10
K31-1	S-IC Engine No. 1 Thrust Monitor No. 1			3		2	3	2

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K31-2	S-IC Engine No. 1 Thrust Monitor No. 2	3		3		2	3	2
K31-3	S-IC Engine No. 1 Thrust Monitor No. 3	3		3		2	3	2
K32-1	S-IC Engine No. 2 Thrust Monitor No. 1					2		
K32-2	S-IC Engine No. 2 Thrust Monitor No. 2					2		
K32-3	S-IC Engine No. 2 Thrust Monitor No. 3					2		
K33-1	S-IC Engine No. 3 Thrust Monitor No. 1					2		
K33-2	S-IC Engine No. 3 Thrust Monitor No. 2					2		
K33-3	S-IC Engine No. 3 Thrust Monitor No. 3					2		
K34-1	S-IC Engine No. 4 Thrust Monitor No. 1					2		
K34-2	S-IC Engine No. 4 Thrust Monitor No. 2					2		
K34-3	S-IC Engine No. 4 Thrust Monitor No. 3					2		
K35-1	S-IC Engine No. 5 Thrust Monitor No. 1					2		
K35-2	S-IC Engine No. 5 Thrust Monitor No. 2					2		
K35-3	S-IC Engine No. 5 Thrust Monitor No. 3					2		

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K39	EDS Bus Changeover B					1	1	1
K40	Excessive Rate Auto-Abort Inhibit (P, Y, & R)					6	6	6
K41	Excessive Rate Auto-Abort Inhibit (Roll)					6	6	6
K42	S-IC Two Engine Out Auto-Abort Inhibit					6	6	6
K43-1	S-IC Two Engine Out Auto-Abort Inhibit No. 1			2		2		6
K43-2	S-IC Two Engine Out Auto-Abort Inhibit No. 2			2		2		6
K43-3	S-IC Two Engine Out Auto-Abort Inhibit No. 3					2		6
K44	LET Jettisoned B1				9	9	9	9
K45	S-IVB Engine Thrust Monitor B					7		7
K46-1	Excessive Rate Auto-Abort Inhibit (P & Y) No. 1			8		8	8	6
K46-2	Excessive Rate Auto-Abort Inhibit (P & Y) No. 2					8		6
K46-3	Excessive Rate Auto-Abort Inhibit (P & Y) No. 3					8		6
K47-1	Excessive Rate Auto-Abort Inhibit (Roll) No. 1			8		8	8	6
K47-2	Excessive Rate Auto-Abort Inhibit (Roll) No. 2					8		6

Relay	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K47-3	Excessive Rate Auto-Abort Inhibit (Roll) No. 3					8		6
K48	LET Jettisoned B2				9	9	9	9
K49	Range Safety Destruct Armed A from S-IVB				7		7	7
K50	Range Safety Destruct Armed B from S-IVB				7		7	7
K51	S-IVB Thrust Monitor A Indicator						7	7
K53	EDS Manual/Auto Cutoff A of S-IC Engines				3		3	3
K54-1	EDS Manual/Auto Cutoff B of S-IC Engines						3	3
K54-2	EDS Manual/Auto Cutoff B of S-IC Engines				3		3	3
K55	S-IC Engines Cutoff Enable						3	3
K56	S-IC Engines Cutoff Enable						3	3
K57	S-IVB Engine Start Command						7	6
K58	S-IVB Engine Prevent Start					7		6
K59	S-IC All Engines OK A					2		2
K60	Excessive Roll Rate Voting Relay A						8	8
K61	Excessive Roll Rate Voting Relay B					8	8	8

Relay	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K62	Excessive Pitch Rate Voting Relay A						8	8
K63	Excessive Pitch Rate Voting Relay B						8	8
K64	Excessive Yaw Rate Voting Relay A						8	8
K65	Excessive Yaw Rate Voting Relay B					8	8	8
K66	EDS Arming of S-IVB Engine Thrust Indication A					7	7	7
K68-1	S-II/S-IVB Separation Simulate					6		6
K68-2	S-II/S-IVB Separation Simulate					6		6
K69	Range Safety S-IVB Destruct Arm B						7	7
K70	Range Safety S-IVB Destruct Arm A						7	7
K71	Pad Abort Request				7		7	7
K72	S-IVB Thrust Monitor A					7		7
K73	EDS Bus Changeover A					1	1	1
K74	LES Abort Lockup A1				9	9	9	9
K75	LES Abort Lockup A2				9	9	9	9
K76	Normal S-IVB Engine Cutoff						7	6
K78	Cutoff S-IC Inboard Engine						3	3
K79	Cutoff S-IC Outboard Engine						3	3

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K80	S-II All Engines Normal Cutoff						4	4
K81	S-II Engine No. 1 Thrust Monitor A						7	4
K82	S-II Engine No. 2 Thrust Monitor A						7	
K83	S-II Engine No. 3 Thrust Monitor A						7	
K84	S-II Engine No. 4 Thrust Monitor A						7	
K85	S-II Engine No. 5 Thrust Monitor A						7	
K90	EDS Liftoff Inhibit A					9		10
K91	EDS Liftoff Inhibit B					9		10
K92	EDS Liftoff Enable A				10		9	10
K93	EDS Liftoff Enable B				10		9	10
K94-1	LV Attitude Reference Fail A				5		5	5
K94-2	LV Attitude Reference Fail B						5	5
K95	LET Jettisoned A1				9	9	9	9
K96	LET Jettisoned A2				9	9	9	9
K97	EDS Abort Voting Logic Input A1	10		9		9		10
K98	EDS Abort Voting Logic Input A2	10		9		9		10

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K99	EDS Abort Voting Logic Input A3	10		9		9		10
K100	EDS Abort Voting Logic Input B1	10		9		9		10
K101	EDS Abort Voting Logic Input B2	10		9		9		10
K102	EDS Abort Voting Logic Input B3	10		9		9		10
K103	Abort B1			10		10	9	9
K104	Abort B2			10		10	9	9
K105	Abort A1			10		10	9	9
K106	Abort A2			10		10	9	9
K107	Auto-Abort System Enable A1		9		9	9	9	9
K108	Auto-Abort System Enable A2		9		9	9	9	9
K109	Auto-Abort System Enable B1		9		9	9	9	9
K110	Auto-Abort System Enable B2		9		9	9	9	9
K111	LES Abort Lockup B1				9	9	9	9
K112	LES Abort Lockup B2				9	9	9	9
K113	Excessive Rate Auto-Abort Inhibit (P, Y, & R)					6	6	6
K114	Excessive Rate Auto-Abort Inhibit (Roll)					6	6	6

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K115	S-IC Two Engine Out Auto-Abort Inhibit Enable					6	6	6
K116	+6D91 Bus GSE Disable					1		1
K117	+6D92 Bus GSE Disable					1		1
K118	+6D93 Bus GSE Disable					1		1
K121-1	S-II Engine No. 1 Thrust Monitor A (Type 1 of 5)			4		4		4
K121-2	S-II Engine No. 1 Thrust Monitor B (Type 1 of 5)					4		4
K122	Excessive Pitch Rate Output No. 1						8	8
K123	Excessive Pitch Rate Output No. 2						8	8
K124	Excessive Pitch Rate Output No. 3						8	8
K125	Excessive Yaw Rate Output No. 1						8	8
K126	Excessive Yaw Rate Output No. 2						8	8
K127	Excessive Yaw Rate Output No. 3						8	8
K128	Excessive Roll Rate Output No. 1						8	8
K129	Excessive Roll Rate Output No. 2						8	8
K130	Excessive Roll Rate Output No. 3						8	8

Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K131	RF Link Abort Request A						7	7
K132	RF Link Abort Request B						7	7
K134	S-IVB Thrust OK Monitor B Indication						7	7
K135-1	Rate Gyro High Rate On A1				8		8	6
K135-2	Rate Gyro High Rate On A2						8	6
K136-1	Rate Gyro High Rate On B1			8		8		6
K136-2	Rate Gyro High Rate On B2			7		8		6
K137	Logic A Bus Arm A						1	1
K138	Logic A Bus Arm B						1	1
K139	Logic B Bus Arm A						1	1
K140	Logic B Bus Arm B						1	1
K149	S-II Second Plane Separation Simulate			5		5		5
K150	S-II Lng Prevalves Close Command						4	4
K151	S-II Engine No. 1 Thrust Monitor B						7	4
K152	S-II Engine No. 2 Thrust Monitor B						7	
K153	S-II Engine No. 3 Thrust Monitor B						7	
K154	S-II Engine No. 4 Thrust Monitor B						7	

Relay	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K155	S-II Engine No. 5 Thrust Monitor B						7	
K156	S-II Range Safety No. 1 Engines Cutoff				4		4	4
K157	S-II Range Safety No. 2 Engines Cutoff				4		4	4
K158	S-IC Engine No 1 Prevalves Close				3		3	3
K159	S-IC Engine No. 1 Cutoff				3		3	3
K160-1	EDS Manual/Auto Cutoff A1 of S-II Engines					4	4	4
K160-2	EDS Manual/Auto Cutoff B1 of S-II Engines						4	4
K161-1	EDS Manual/Auto Cutoff A2 of S-II Engines					4	4	4
K161-2	EDS Manual/Auto Cutoff B2 of S-II Engines						4	4
K162-1	S-II LH_2 Prevalves Close Command from Engines Prevent Start						4	4
K162-2	S-II LH_2 Prevalves Close Command from Engines Prevent Start							4
K162-3	S-II LH_2 Prevalves Close Command from Engines Prevent Start							4

Relay #	Function	Contacts - Schematic Sheet No.						
		NC	NO	NC	NO	NC	NO	Coil
K163	S-II Start Phase Limiter Cutoff Arm						4	4
K166	Engine Start Interlock By-pass						7	6
K167	EDS Arming of S-IVB Engine Thrust Indication B					7	7	7
K171	GSE Engine Thrust Indication Enable A			7		7		7
K172	GSE Engine Thrust Indication Enable B			7		7		7
K173	EDS Arming of S-II Thrust Indication A				5	7	4	4
K174	EDS Arming of S-II Thrust Indication B				5	7	4	4
K198	S-IVB Prevalve Control Command						7	6
K199	S-IVB Chilldown Shutoff Command						7	6
K201-1	S-II Second Plane Separation A						5	5
K201-2	S-II Second Plane Separation B						5	5
K202	S-IC Range Safety Engines Cutoff A				3		3	3
K203-1	S-IC Range Safety Engines Cutoff B1				3		3	3
K203-2	S-IC Range Safety Engines Cutoff B2						3	3

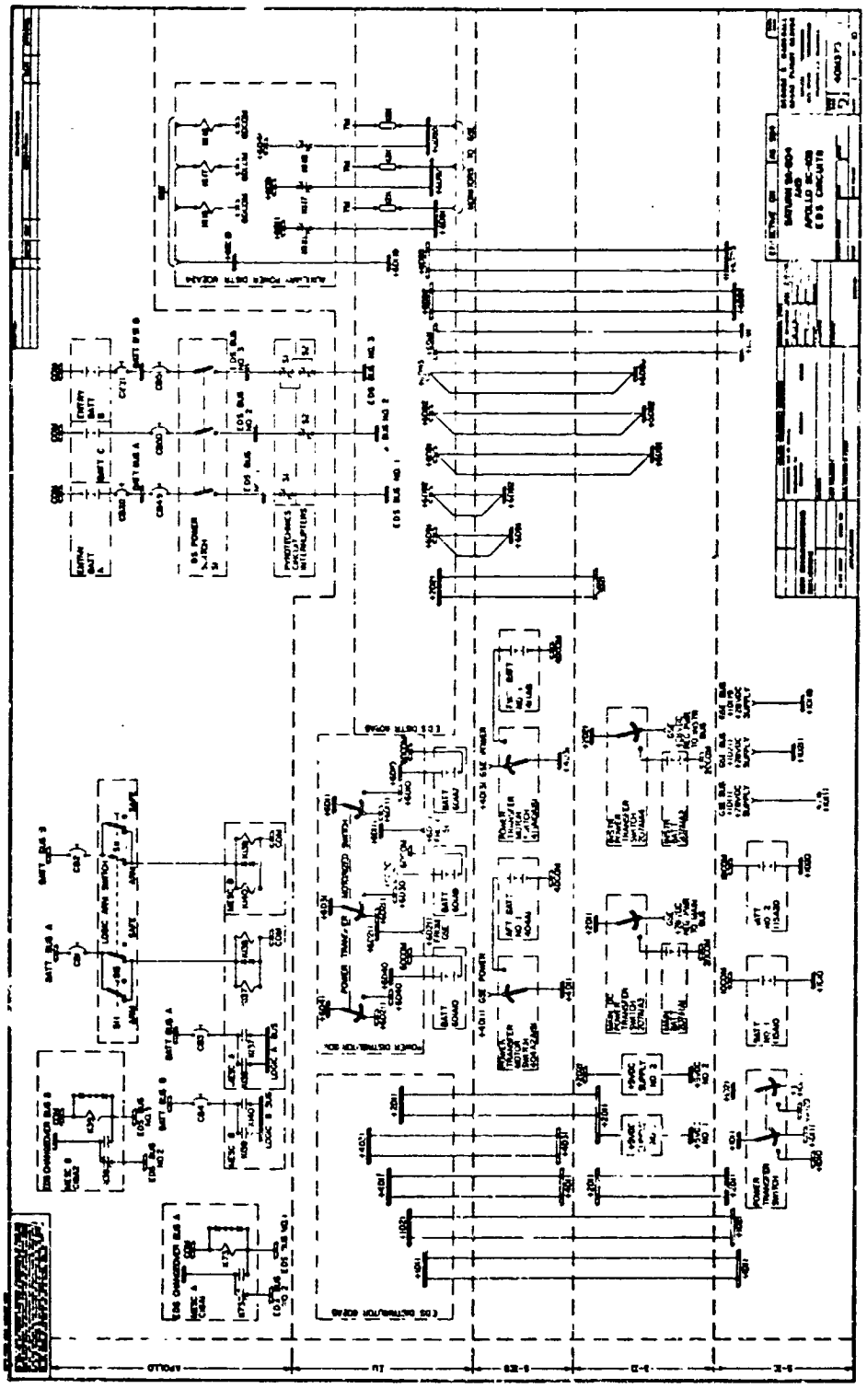
Relay #	Function	Contacts - Schematic Sheet No. NC	NO	NC	NO	NC	NO	Coil
K208	S-II Engine No. 1 Cutoff					4	4	4
K209	S-II Engine No. 1 LOX and LH_2 Prevalves Control				4		4	4
K210	S-II Prevalve Lockout Command from GSE					4	4	4
K212	Timers Test				2		6	6
K214-1	Normal S-II Engines Cutoff B1						4	4
K214-2	Normal S-II Engines Cutoff B2						4	4
K215-1	Normal S-II Engines Cutoff A1						4	4
K215-2	Normal S-II Engines Cutoff A2						4	4
K216	S-II All Engines Start Command						4	4
K217	S-II Engines Prevent Start					4		4
K218	S-II Engines Prevent Start By-pass Command					4		4
K219	S-IC All Engines OK B					2		2
K220	Excessive Roll Rate Indication				7		7	8
K221	Excessive Pitch and Yaw Rate Indication A				7		7	8
K222	Excessive Pitch and Yaw Rate Indication B				7		7	8

DRAWING NOTES:

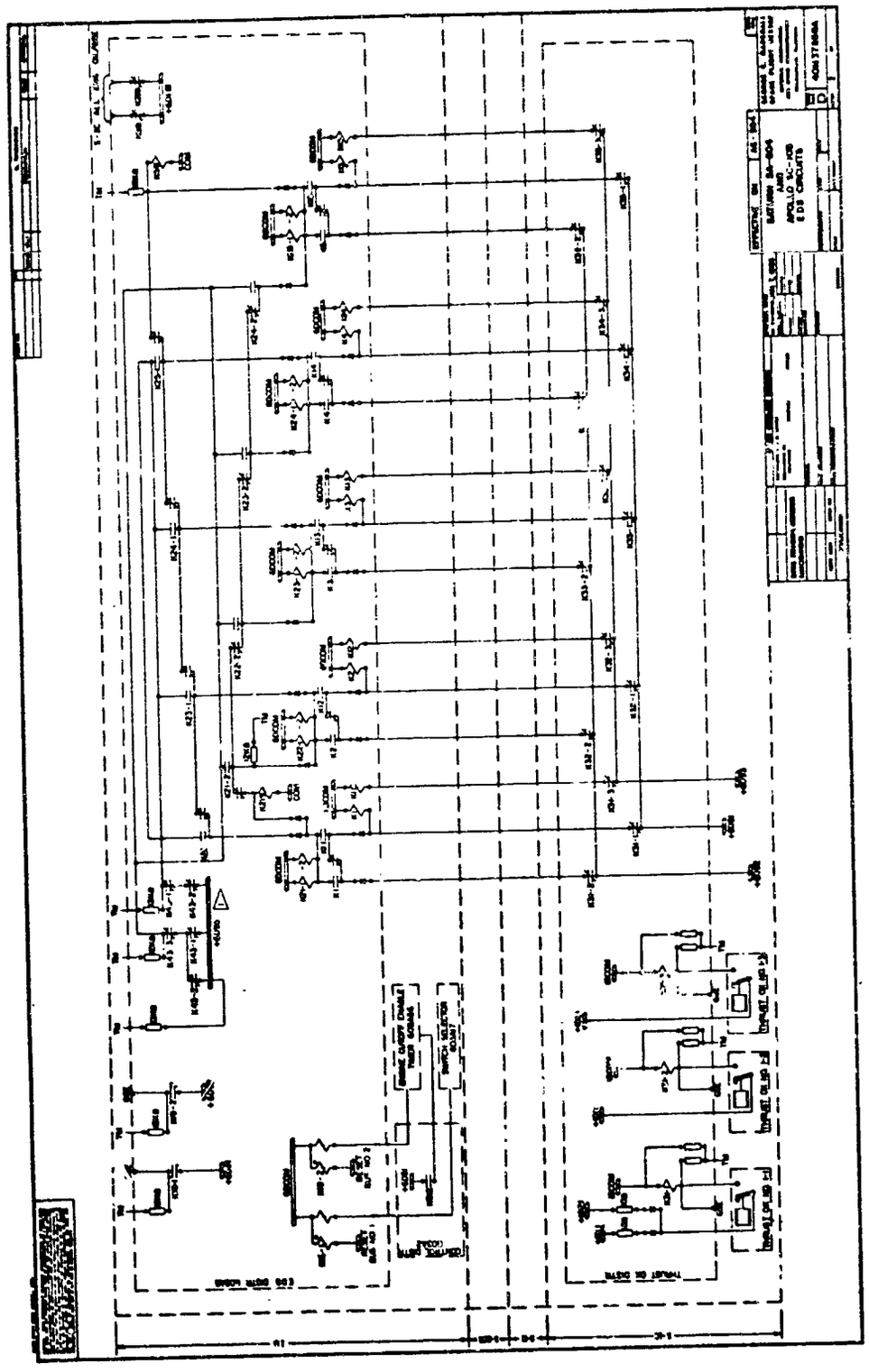
1. The Auto-Abort bus, +6D95, can be energized from the excessive rate circuit as well as the two engine out circuit.

2. This function is not programmed on the switch selector for this mission.

3. This circuit is not active on this mission and the function is inhibited.



APOLLO INTERFACE DOCUMENT



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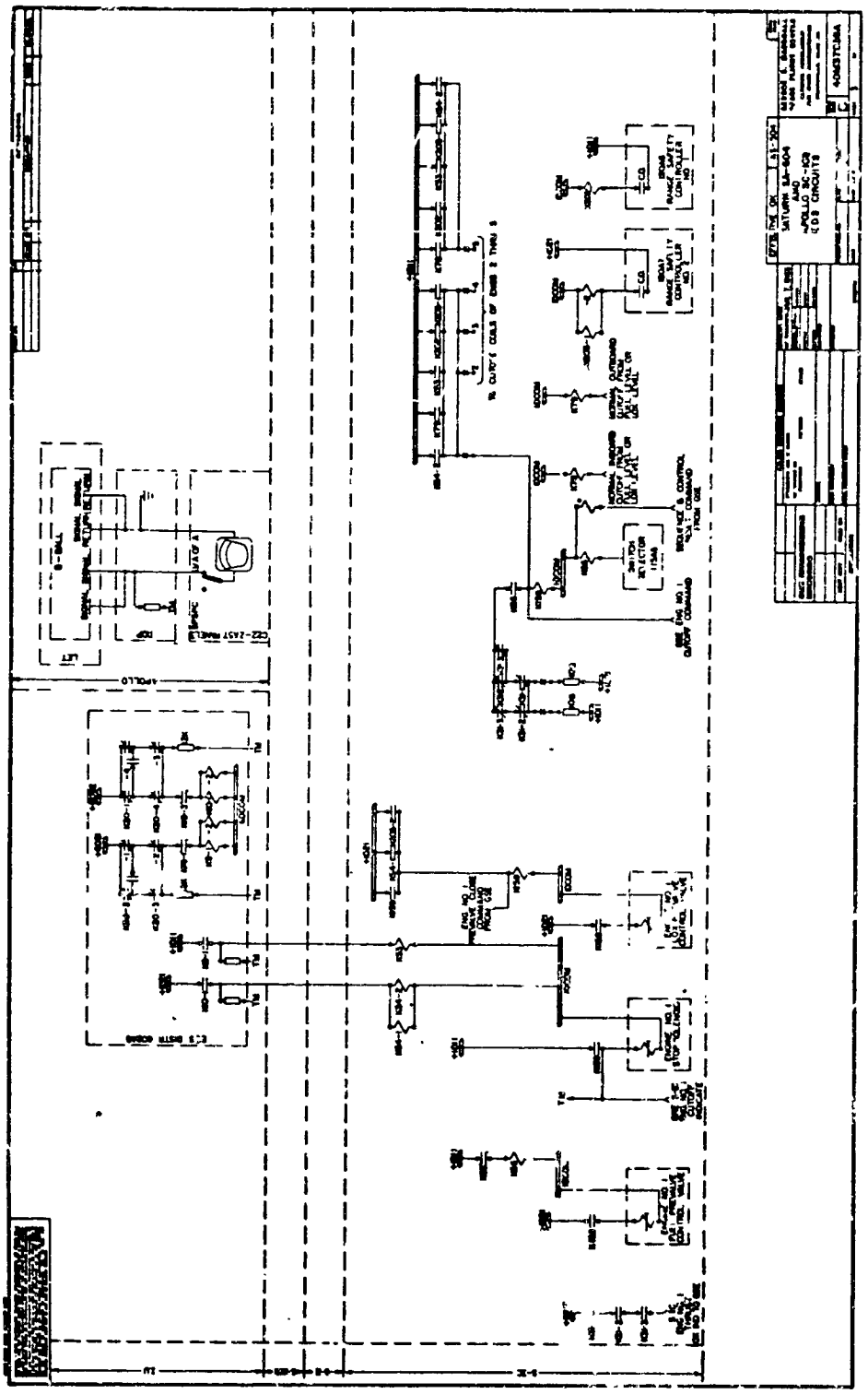

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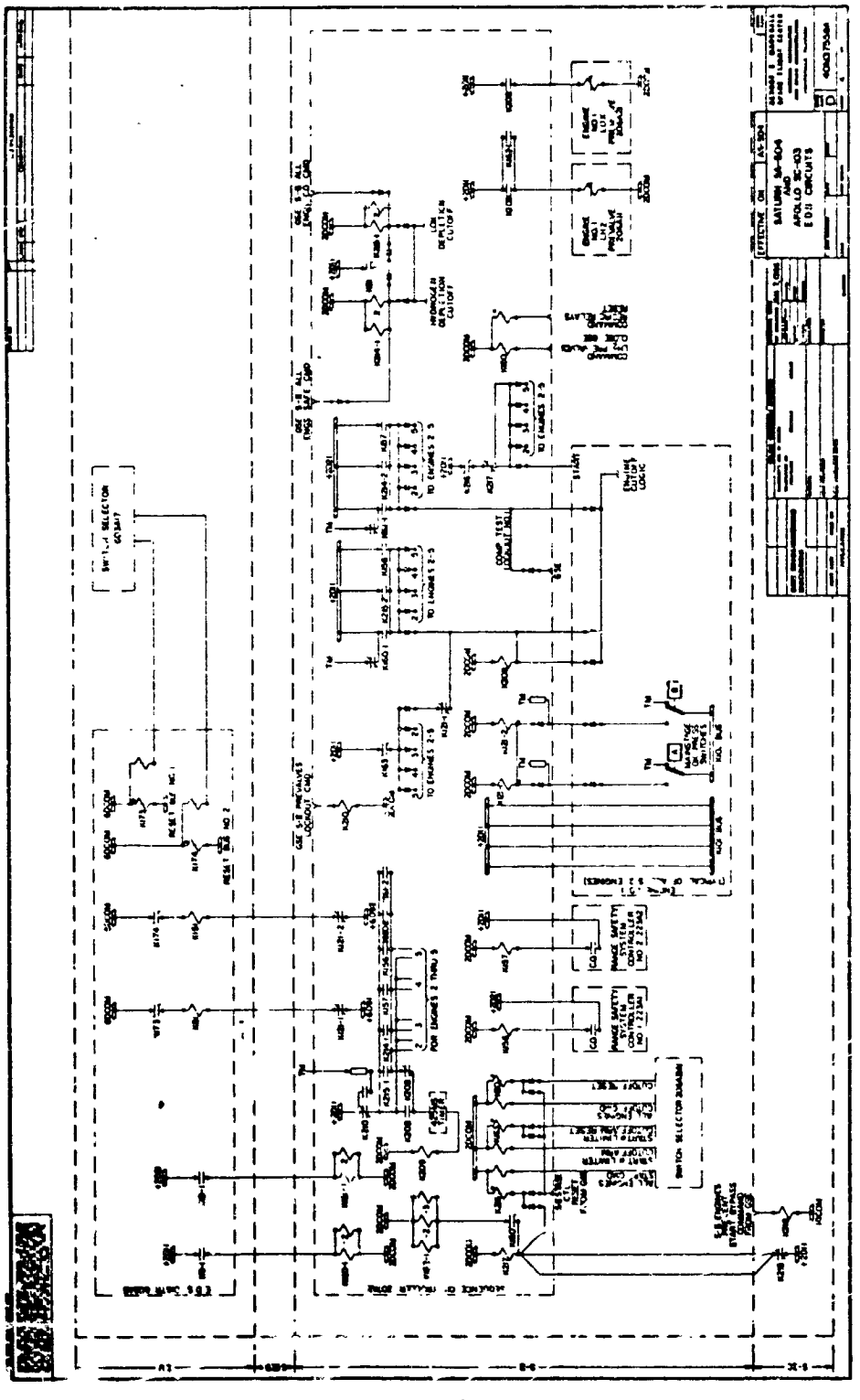

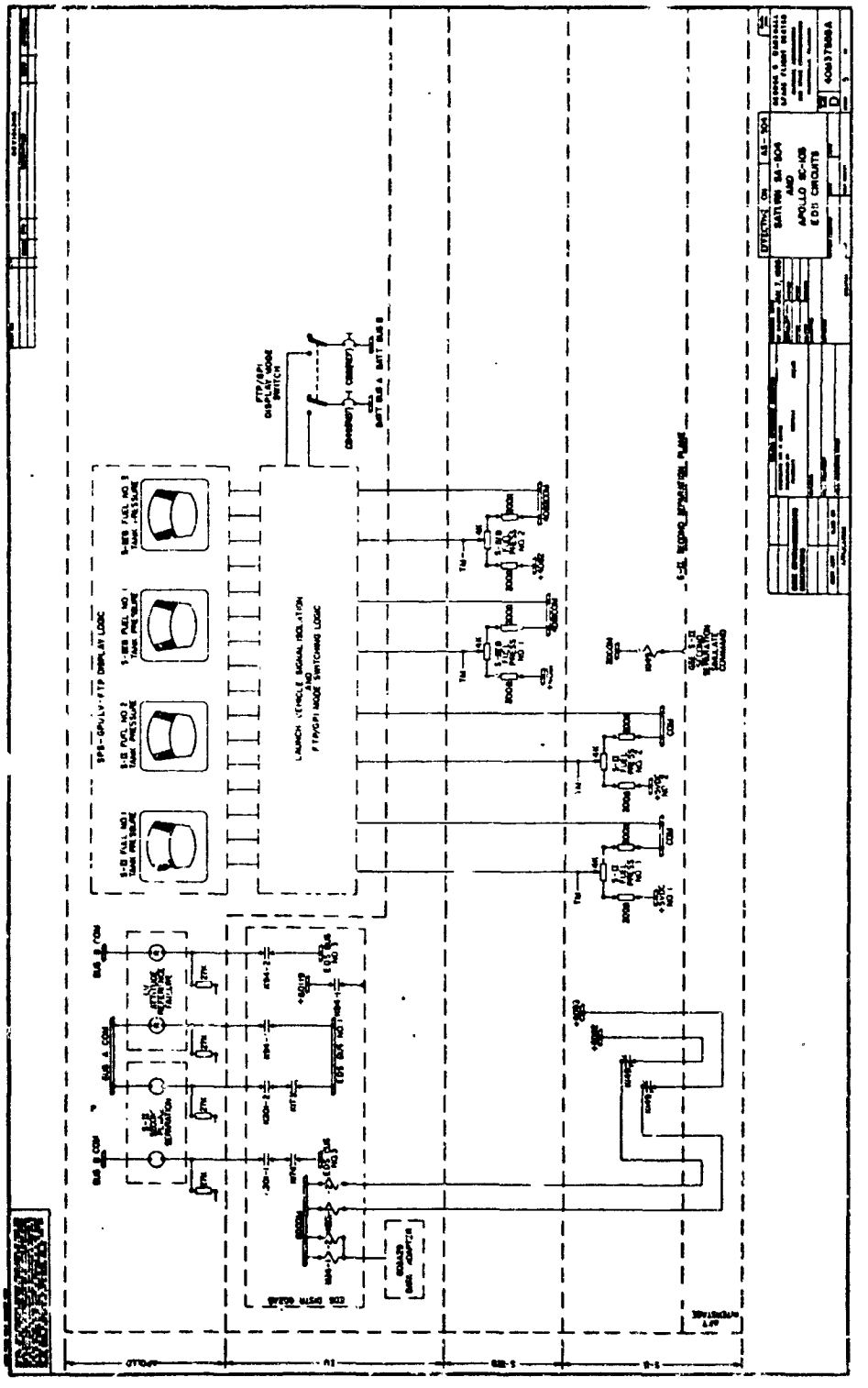

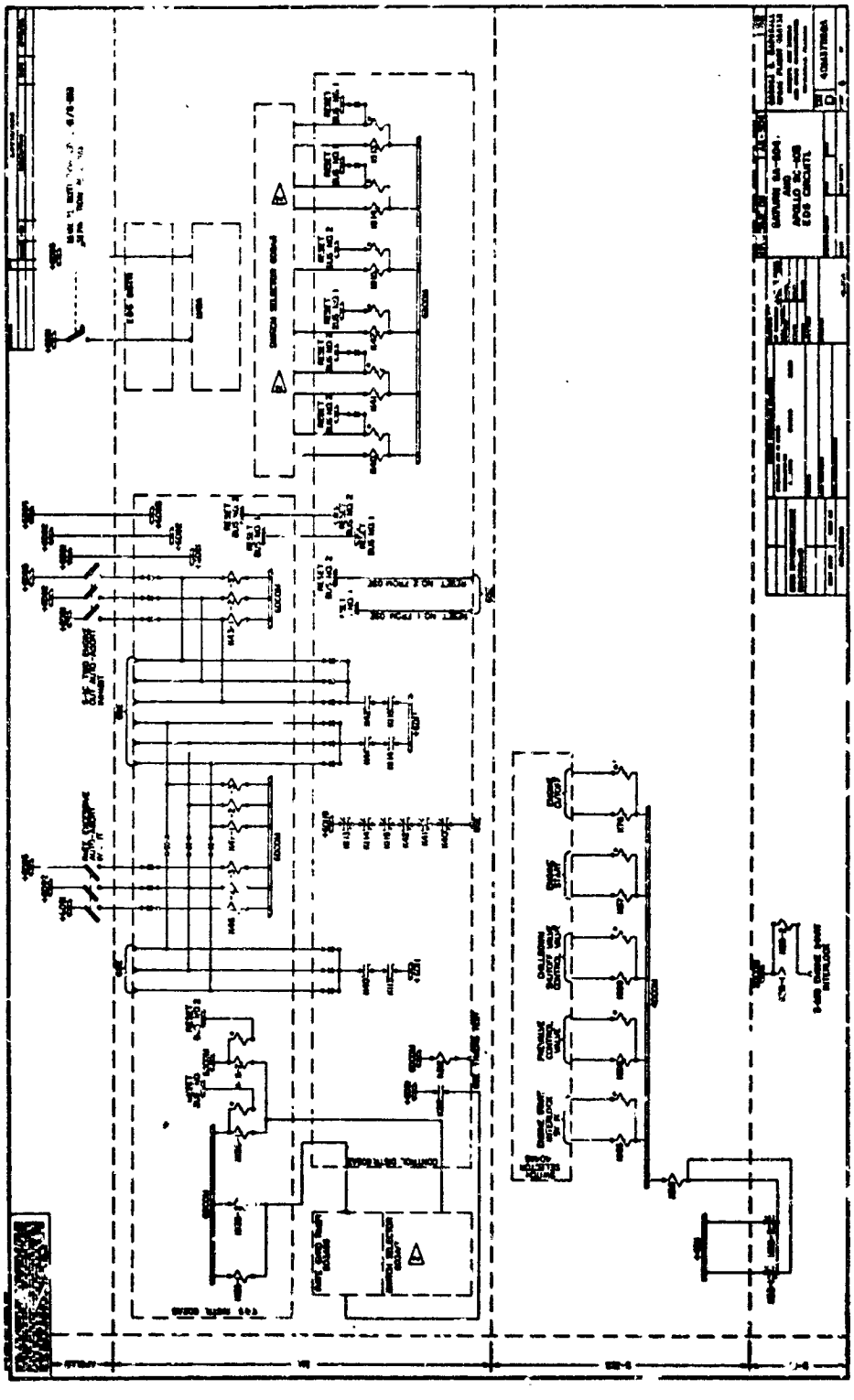

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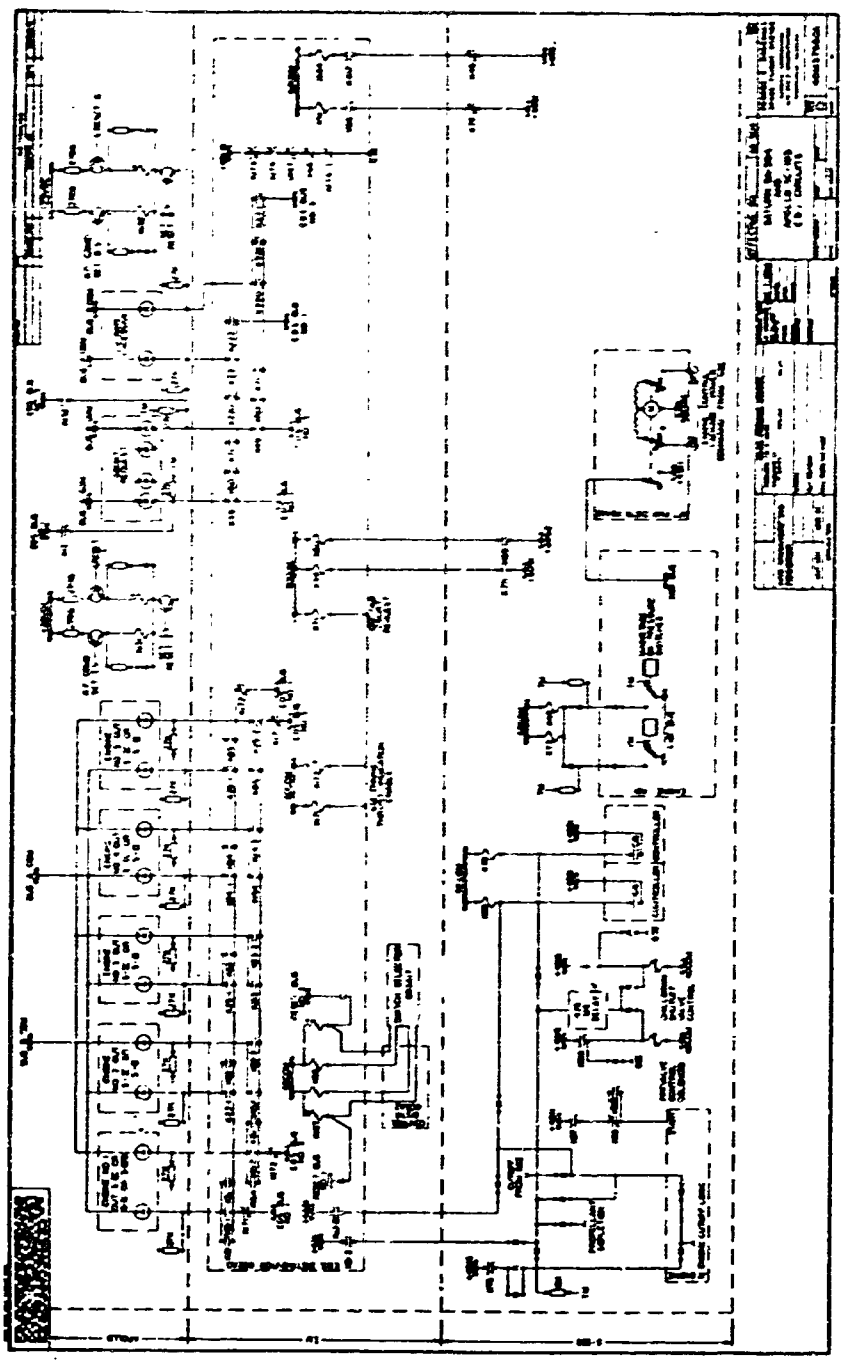

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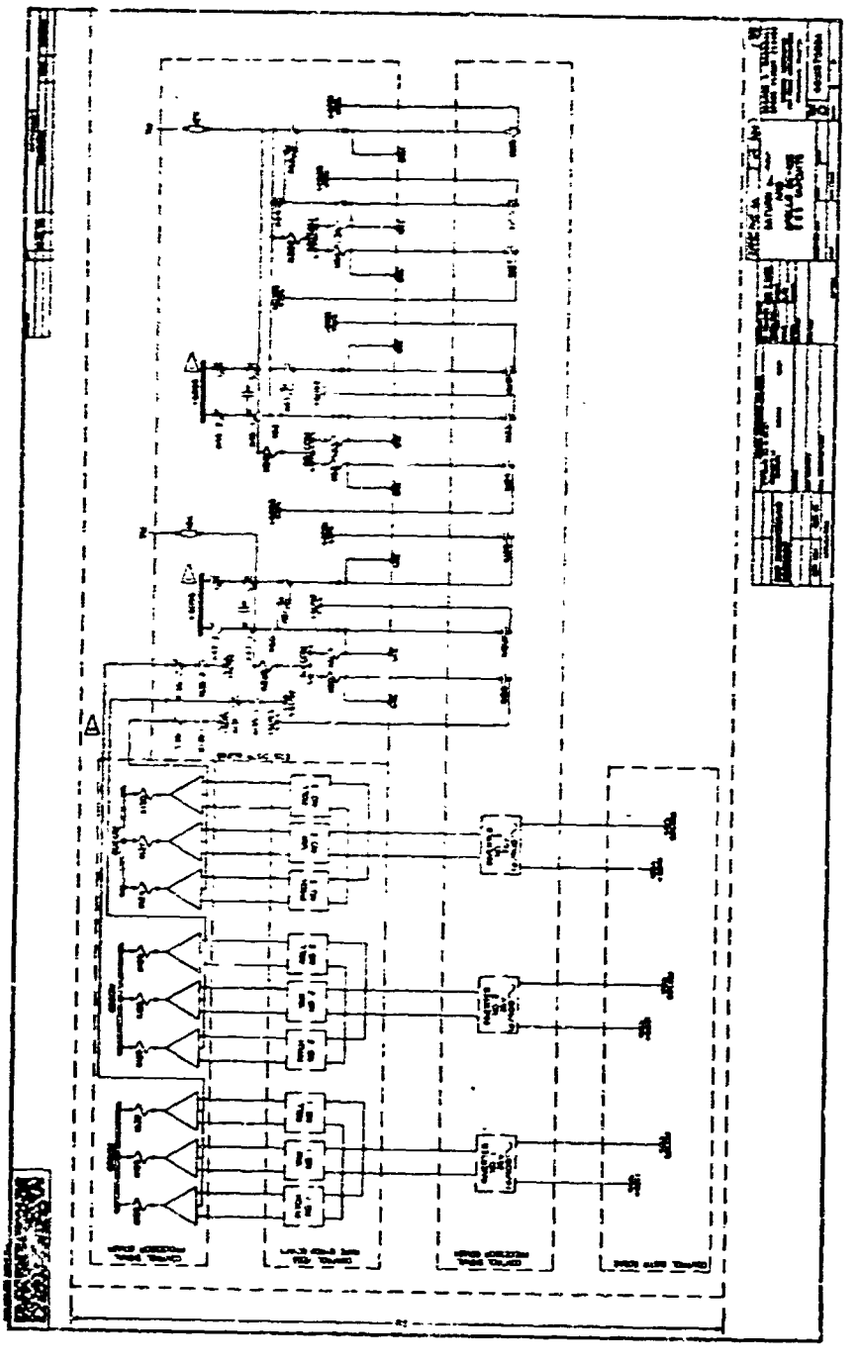

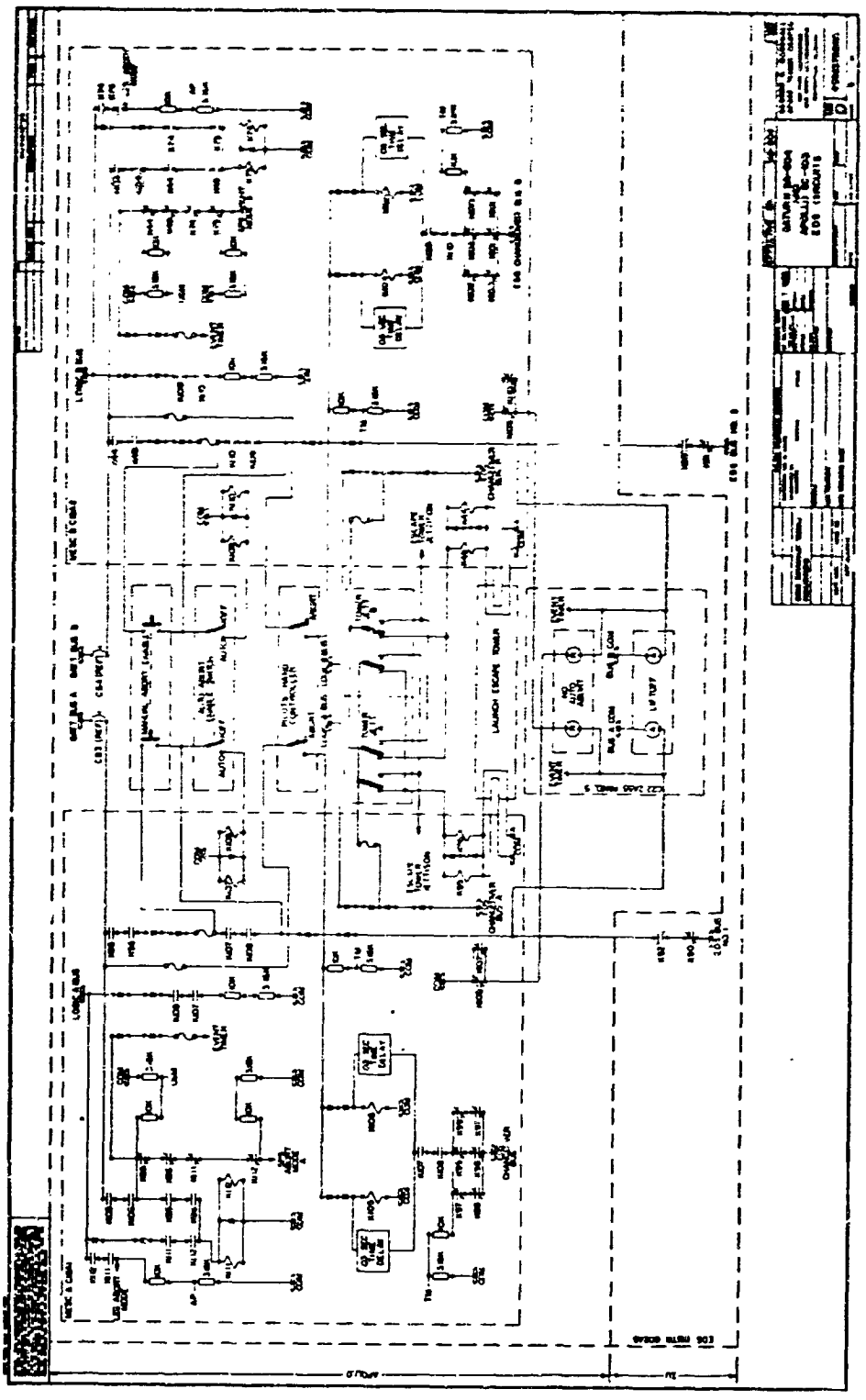

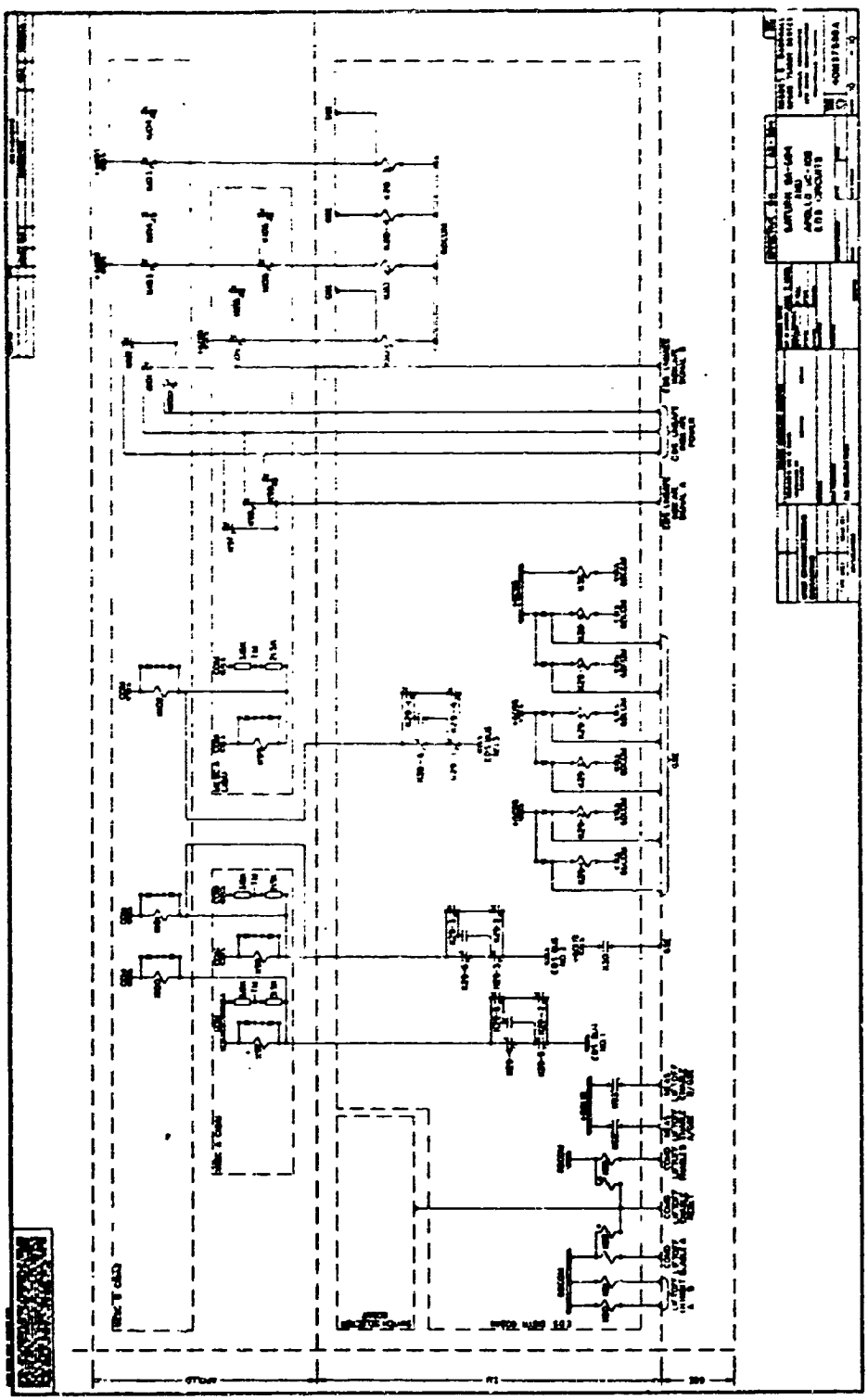

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